European Commission

JRC SCIENTIFIC AND POLICY REPORTS

ERA Fabric Map

Second Edition

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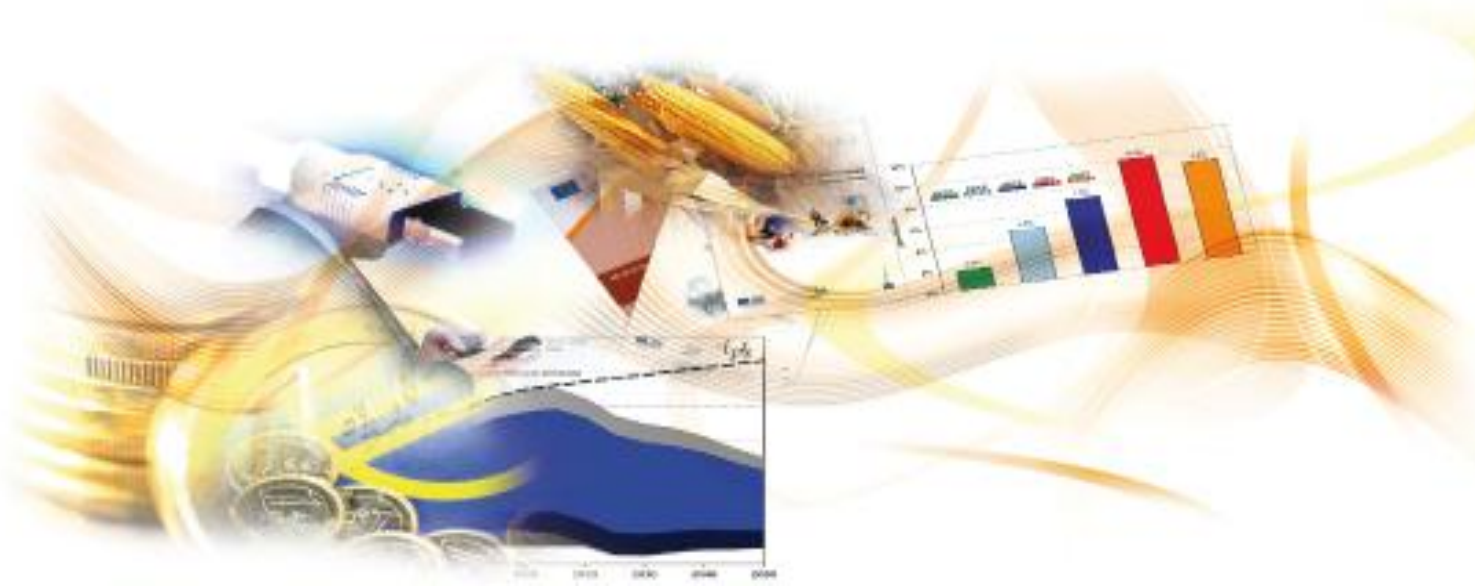
2014



Report EUR 26433 EN

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JRC 85302

EUR 26433 EN

ISBN 978-92-79-35074-0 (pdf)

ISSN 1831-9424 (online)

doi:10.2791/63680

Luxembourg: Publications Office of the European Union, 2014

Visions for the European Research Area – VERA

ERA Fabric Map

Second Edition

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Executive summary

This updated ERA fabric map provides input for the implementation of the 'Visions for the ERA' (VERA) project by giving a snapshot of the European Research Area (ERA), in support of developing alternative future scenarios for its evolution.

The report maps the evolution of the ERA, highlighting the elements of continuity and discontinuity between the 2007 ERA-Green Paper (EC 2007a), organised along 6 dimensions, and the 2012 ERA Communication (EC 2012a), framed across 5 priorities. Whilst there is a large overlap between the two approaches, interesting differences emerge. In 2007, the relationships between the ERA and third countries were considered as a distinct dimension. In 2012, however, rather than being a priority in itself, it permeates all five priorities. Secondly, the issue of gender and research, included as part of the former dimension 1, is - in 2012- a priority in itself (priority 4). Finally, the current priority 1, addressing the effectiveness of national research systems, does not correspond to any one of the dimensions of 2007 and represents a major novelty. Through it, Member States are required to put project-based funding and institutional assessment at the core of research funding.

The second ERA Fabric Map gives a thorough description of the governance of the ERA, presenting the concepts of the Open Method of Coordination and of Partnership between the EC, the Member States and Stakeholders. The ERA can be seen as situated at the interface of various policy-domains, with some falling under the responsibilities of Member States and others under the shared responsibility of Member States and the Commission. This effectively means that policies shaping European research and innovation are bound to be based on collaboration and voluntary engagement of the Member States and their respective stakeholders.

The links between the ERA and third countries have been and continue to be a key object of attention. The report maps the evolution of such links, looking at the past and at the forthcoming multiannual financial framework. The European Union not only acknowledges the increasing internationalisation of research and innovation, but actively embraces it with policies aimed at strengthening and harnessing it. In general, two sets of objectives for international science, technology and innovation (STI) cooperation policies can be distinguished. The first are intrinsic in nature and include striving for excellence and improving research systems by increasing cooperation or building infrastructure. The second are extrinsic, in that they focus on the support of other policies e.g. foreign, development or economic policies (ERAWATCH Network ASBL, 2013).

Finally, the report takes a close look at the state of the art and evolution of the five ERA priorities. It focusses on where we are today and which direction the future is taking, framing the discussion against the policy context of the Europe 2020 strategy and the incoming Multiannual Programming Framework 2014-2020. It looks at the division of responsibilities between the EU and its Member States, and at institutions and bodies involved in the European research system. The development of the ERA can be summarised as follows.

Priority 1: **More effective national research systems.** Across the EU, various national research performers have access to very different levels of public R&D funding. The heterogeneity of the R&D landscape is further increased through the use of various funding mechanisms. This priority aims at increasing the efficiency with which funds are allocated, by introducing or enhancing the use of competitive funding through calls for proposals and institutional assessments, and by applying the principles of international peer review. The

share of public funds allocated via competitive calls for projects is generally increasing. However, the use of regular, efficient, and transparent institutional assessment as a basis for the allocation of funding is still at a relatively early stage in most countries. Official statistics on the use of competitive funding are not available, rendering the quantitative monitoring difficult.

Priority 2: **Optimal transnational co-operation and competition and research infrastructures**. Europe 2020 and the 2012 ERA Communication stress the importance of R&D (and R&D infrastructure) to tackle social challenges and increase competitiveness. They urge Member States to act coherently to achieve the scale of effort and impact needed to address them. Synergies and reinforced interoperability between national research systems in terms of strategic agendas, research infrastructures but also processes are the backbone for "Optimal transnational co-operation and competition". The ERA Communication recognises that the current level of alignment is too low (4.27% of total 2010 GBAORD including national contributions to ESA, or 1.47% without those contributions) to have a serious impact on large and complex challenges. Under unchanged conditions this is not likely to change drastically. Significant differences also exist between countries, both with regard to R&D expenditure and R&D Infrastructure.

Priority 3: **An open labour market for researchers.** This priority refers to the need to select, attract and nurture researchers across the EU, ensuring the sustainability of the profession by providing adequate types of career support and rewards. While the principles of open, merit-based and transparent recruitment –critical for an open labour market– appear increasingly recognised in the regulations and legislation, difficulties persist in implementing them. This is partly due to the fact that European MS vary remarkably in their conditions of recruitment and employment, and thus in their ability to attract both national and foreign researchers. Such fragmentation is one of the main obstacles to the creation of a single labour market for researchers.

Priority 4: Gender equality and gender mainstreaming in research. Priority 4 covers the issue of gendered science, including and going beyond the issue of equality of opportunities, actively fostering higher female participation in research to end the waste of talent currently experienced across the EU. The concept of gender mainstreaming is critical for this priority. It involves, as well as promoting and monitoring female participation in research activities, taking into account the gender dimension of research. The latter implies avoiding gender-blindness when setting up a research agenda, taking into account both male and female preferences and exploring scientifically the gender dimension of any topic. Through various types of measures (laws, government strategies, activities promoting cultural shifts), MS are moving towards greater gender inclusion in science and research. However, the lack of evaluation studies, does not allow the level of implementation of such measures to be assessed.

Priority 5: **Optimal circulation, access to and transfer of scientific knowledge**. This priority refers to the need to (i) Implement policies and measures on Open Access to and preservation of scientific information; (ii) foster knowledge transfer between public and private sectors; (iii) harmonise policies for public e-infrastructures and for associated digital research services, enabling consortia of different types of public and private partners; and (iv) implement national strategies for electronic identity for researchers giving them transnational access to digital research services. The need to involve both public and private partners is explicit in items (ii) and (iii), converting these actions into a test bed for knowledge

triangle initiatives. This priority is characterized by the dominance of stakeholders' involvement rather than top-down policy initiatives.

Formal progress is being made across all five priorities in relation to the ERA goals, although much more needs to be achieved especially in terms of monitoring and evaluation. Furthermore, the ERA priorities seem well engrained in the EU2020 Strategy, its flagship initiatives, Horizon 2020 and the Multiannual Financial Framework 2014-2020.

Taking into account the complexity and multi-layered nature of the ERA, it seems necessary to define not only the direction, towards which the Union should move, but also adequate monitoring and evaluation goals. This requires a more refined definition (both broader and deeper) of the actions within each priority and further attention at the intersections between the different priorities.

Acknowledgements

The authors would like to acknowledge Mark Boden for his useful comments.

1. Introduction

This Report is the fourth deliverable of Work Package 6 "Stakeholder Engagement and Communication Strategy" of the VERA Project (Forward Visions on the European Research Area). It constitutes an update of the first edition of the ERA Fabric Map (D.6.1)

As with the first edition, the main objectives is to provide strategic knowledge for the governance of the research, technology, development and innovation (RTDI) system in Europe.

The report follows largely the same structure of the first edition, adopting a new perspective in light of the key policy changes occurred. In particular, whilst the first edition of the report was framed in line with the 2007 ERA Green Paper, and its six dimensions, the current Map reflects the five priorities and the actions under each of them, described in the 2012 ERA Communication (EC, 2012a).

The report is structured as follows. Section 2 reviews the historical evolution of the ERA. Section 3 describes the multi-layered governance of the ERA, looking at the role of shared responsibilities and inter-governmental institutions. Section 4 describes the international dimension of the ERA, a cross-cutting theme across the 5 priorities. Section 5 explores the state of the art of ERA, building on the five ERA priorities of the EC 2012 ERA-Communication, and putting them in the context of the Europe 2020 strategy and the forthcoming Multiannual Financial Framework 2014-2020.

As with the first edition of the report, the proposed ERA fabric map aims to provide a point of reference for the whole implementation of the VERA project by giving a snapshot of the ERA today in support of developing alternative future scenarios for its evolution.

2. The evolution of the European Research Area

The concept of the European Research Area (ERA) was first launched at the Lisbon European Council in March 2000 (EC 2000a). Previous to that, the landscape of research in Europe was scattered and divided: the EU Framework Programme supported mainly small scale cross-border projects, a small set of joint research centres was in place, the EU involvement in other European programmes was limited and national research policies were largely closed. The Lisbon Council gave a wake-up call for a change in research and innovation governance at the EU level, proposing the innovative concept of the European Research Area. The concept, as originally defined, promoted increased co-ordination and cooperation among national research policies and programmes, all aspects that have since been supported and enhanced through different instruments.
Two years after the introduction of the ERA, the Barcelona European Council set a 3% of GDP target for EU R&D investment intensity .The target, for the first time, committed national policy to EU goals without providing specific EU instruments.
The ERA received new impetus in 2007 with a Green Paper of the European Commission (EC 2007a) which identified the 6 pillars analysed in the previous edition of the ERA Fabric Map, namely:

- realising a single labour market for researchers,
- developing world-class research infrastructures,
- strengthening research institutions,
- sharing knowledge,
- optimising research programmes and priorities,
- opening to the world: international cooperation in S&T).

In 2008, the Council set in motion the Ljubljana Process to improve the political governance of ERA. It adopted a shared ERA 2020 vision, which rooted the ERA in the European Society and tradition, with the ambition to serve the EU's needs and support its sustainable development. Concrete progress has also been made via a series of new partnership initiatives proposed by the Commission in 2008, whereby Member States collaborated to further the ERA in five key areas, namely*: (a)* working conditions and mobility of researchers; *(b)* the joint design and operation of research programmes; *(c)* the creation of world-class European research infrastructures; *(d)* the transfer of knowledge and cooperation between public research and industry and *(e)* international cooperation in science and technology.
In 2009, when the Lisbon Treaty came into effect, the ERA was made an explicit EU objective. The Lisbon Treaty also codified the Lubljiana process in article 181, putting forward the specific request that EU and national STI policies shall, in the future, be coordinated to ensure consistency. Moreover, for the first time, the Lisbon Treaty defined the distribution of competences between the EU and the Member States in the areas of research, technological development and space as a "shared".
Since 2010, seven flagship initiatives – under the Europe 2020 strategy (EC 2010a) – have been launched, with display significant complementarity with the ERA (as explained in the first edition of the Fabric Map). This is especially the case for three initiatives: the "Innovation Union", "Youth on the Move" and "A Digital Agenda for Europe" (all under the "Smart Growth Pillar".

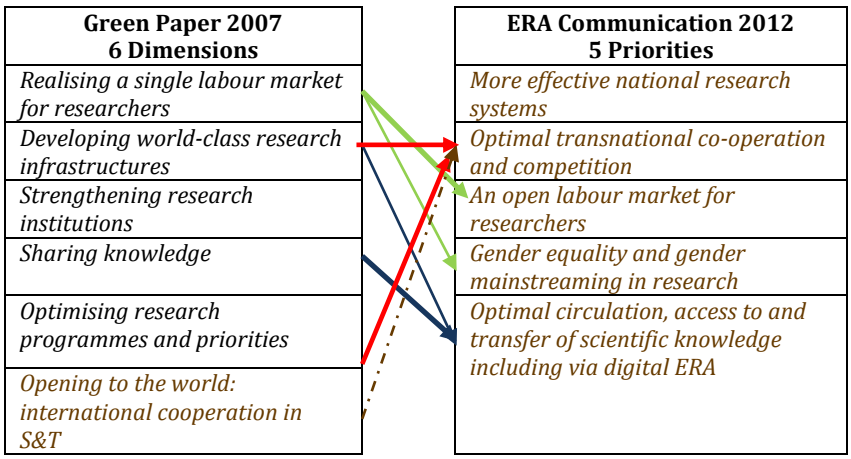
In 2011, the European Council stated that the ERA must be completed by 2014. The message has been re-iterated in the 2012 ERA Communication (EC 2012a), which took stock of the progress made and identified 5 ERA-priorities, namely:

- More effective national research systems
- Optimal transnational co-operation and competition
- An open labour market for researchers
- Gender equality and gender mainstreaming in research
- Optimal circulation, access to and transfer of scientific knowledge including via digital ERA

In the Communication, the priorities are operationalized into three sets of actions directed, respectively, to member states, research organisations and the EC itself. Such priorities are at the core of this ERA Fabric Map, which will highlight the progress made so far, the instruments use and those foreseen in the following multiannual financial framework.

Box 1 From 6 dimensions to 5 priorities

There are both a large overlap and some crucial differences between the six ERA2007 dimensions and the five 2012 priorities, as pointed out in the graph below. The thickness of the arrows reflects the strengths of the link between the two.



ERA **priority 1** does not correspond directly to any one of the previous six dimensions and, in this sense, represents a major novelty. It is only with the formalisation of ERA priority 1 that MS are required to put project base funding and institutional assessment at the core of research funding.

Priority 2 combines elements from several of the former ERA dimensions: dimension 2 "Developing world-class research infrastructures", dimension 5 "Optimising research programmes and priorities", and dimension 6 "International cooperation in S&T" which, as explained below, now cuts across all five priorities.

We see that the previous dimension 1 "Realising a single labour market for research" largely overlaps with the 2012 **priority 3** "An open labour market for researchers". Interestingly whilst the issue of gender, was tackled within dimension 1 in 2007, it receives a larger level of attention in 2012, with a priority of its own (**priority 4**).

What was dimension 4, i.e. "Sharing knowledge", largely overlaps with the 2012 **priority 5** "Optimal circulation, access to and transfer of scientific knowledge including via digital ERA." In addition, some specific aspects initially covered within dimension 2, such as electronic infrastructures, are now tackled in priority 5.

An important difference between the 2007 and 2012 documents relates to the internationalisation of the ERA, i.e. its relationships with third countries. Whilst in 2007 this was considered as a distinct dimension, in 2012 rather than being a priority in itself, it permeates all five priorities(especially priority 2).

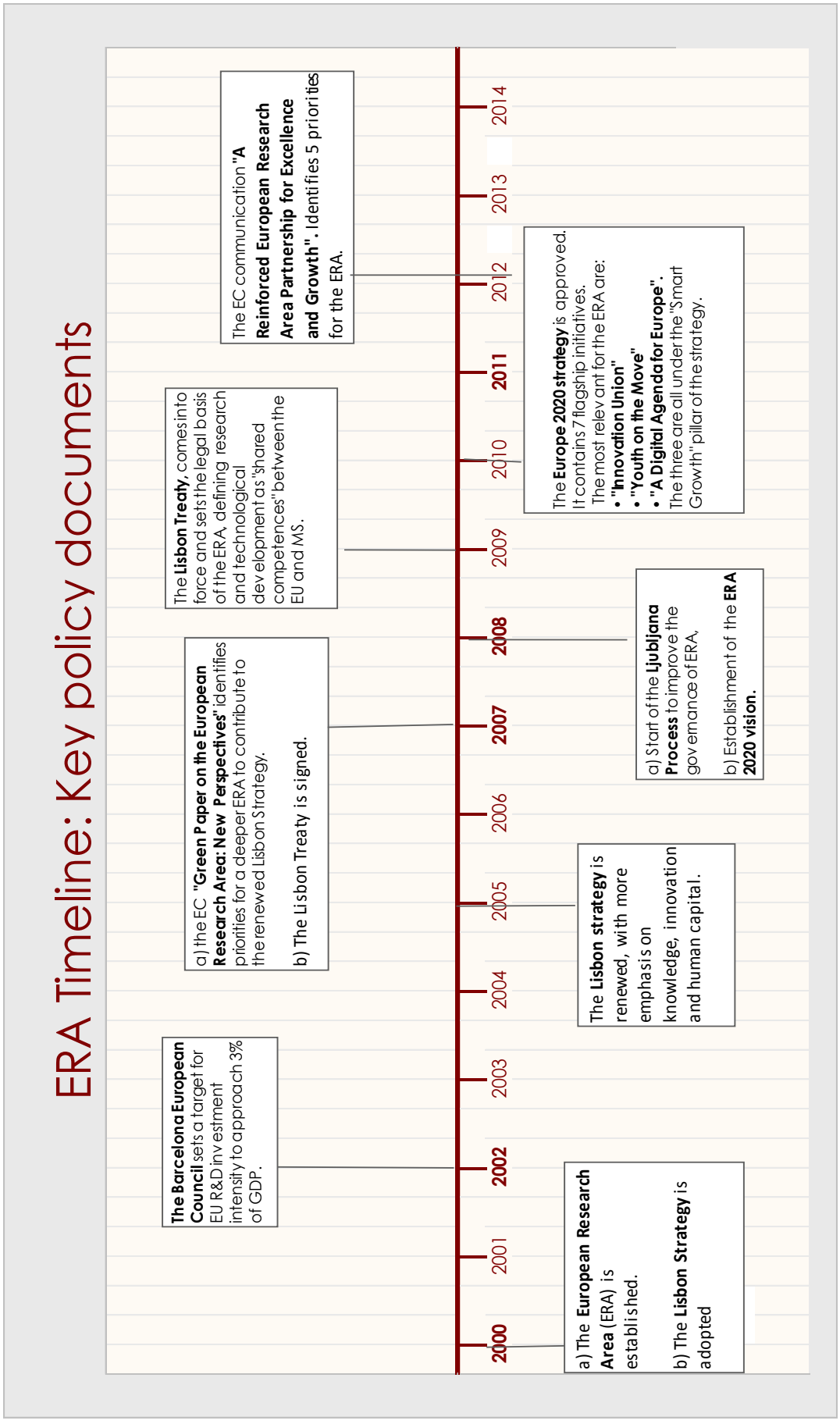


Figure 1 ERA Timeline: Key documents

3. The governance of the ERA: the role of MS, the EU, and other organisations

3.1 The governance of the ERA: shared responsibilities and open method of coordination

When looking at the European RTDI system, not only research, technology and innovation policies are important. A wide set of other policies interact with this system too, many of which lie not in the (sole) responsibility of the European Union.

In general, the responsibilities for policy-making within the European Union can be divided into three categories: those under the responsibility of the EU, those where the European Union and its Member States share responsibilities, and those where the European Union can only play a supporting or co-ordinating role. Responsibilities for the RTDI system, which are at the core of the ERA, are shared ones, as are many related policies, such as economic and social cohesion, energy, transport. However, some key responsibilities connected to research and innovation, such as education, lie with Member States only. This effectively means that policies shaping European research and innovation are bound to be based on collaboration and voluntary engagement of the Member States and its actors.

European institutions involved in research policies work under the co-decision procedure: the Council of the European Union (Council of Ministers) and the European Parliament amend, adopt or reject legislation proposed by the Commission. The negotiation process is long and complex and characterised by considerable informal exchange of views. For the European Parliament, the "Industry, Research and Energy" committee (ITRE) does the preparatory work. For the Council, work is prepared by the Council's Research Working Party, the Permanent Representative's Committee (Coreper) and the Competitiveness Council. Finally, also the European Economic and Social Committee are involved (Source: ERAWATCH, 2012)[1].

Regarding the co-ordination activities at the Member State level, the open method of coordination was introduced by the Lisbon European Council (2000) as a "means of spreading best practice and achieving greater convergence towards the main EU goals". The method includes:

- Fixing guidelines and timetables for achieving short, medium and long-term goals;
- Establishing quantitative and qualitative indicators and benchmarks, tailored to the needs of Member States and sectors involved, as a means of comparing best practices;
- Translating European guidelines into national and regional policies, by setting specific measures and targets; and
- Periodic monitoring of the progress achieved in order to put in place mutual learning processes between Member States.

[1] For a detailed description of the decision making process in the field of research policy, see ERAWATCH: http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/european_perspective/EU_Profile/eu_profile?section=MainResearch&subsection=EuropeanPolicy

3.2 European institutions, bodies and discussion fora involved in research policy in Europe

Having described the institutional mechanisms that regulate the interaction between MS and EU institutions, it is important to look at the main EU-level and inter-governmental organisations that shape the debate and governance of the European Research Area.

EU level organisations shaping the ERA

At the EU-level, the most important official advisory bodies and fora for discussion among policy-makers are described below:

- The European Research Area Committee (ERAC), former CREST, is the advisory body assisting the Council of the European Union and the European Commission in the field of research and technological development. A number of candidate and associated countries participate as observers in ERAC[2]. ERAC has several dedicated working groups, including:
    - The High Level Group for Joint Programming (GPC[3]) is responsible for identifying themes for joint programming. Members are senior officials from European Member States and the European Commission. Associated countries can participate in the GPC.
    - The Strategic Forum for International Cooperation (SFIC) brings together EU Member States, the European Commission and countries associated to the Framework Programme (the latter as observers) to facilitate the development, implementation and monitoring of the international dimension of ERA. This is done by sharing information and jointly identifying priorities. So far, SFIC has been focusing on India, China and the US in the form of pilot initiatives and cooperation priority setting.
    - The Knowledge Transfer Group is established to take up and support the implementation of the EC's Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations EC (2008)
- The Steering Group on Human Resources and Mobility (SGHRM) has been active since 2002 and has been recognised by the Council in 2008 to be the appropriate forum for promoting and monitoring the implementation of the European Partnership for Researchers.
- The European Research Advisory Board (ERAB), previously EURAB, is a high-level, independent, advisory committee created by the Commission to provide advice on the design and implementation of EU research policy, and consists of 45 top experts from EU countries and beyond.
- The European Strategy Forum on Research Infrastructures (ESFRI) aims to support a coherent and strategy-led approach to policy-making on research infrastructures

[2] Albania, Bosnia & Herzegovina, Croatia, Faroe Islands, Former Yugoslav Republic of Macedonia, Iceland, Israel, Liechtenstein, Moldavia, Montenegro, Norway, Serbia, Switzerland and Turkey.

[3] GPC : Groupe de haut niveau pour la Programmation Conjointe

in Europe, and to facilitate multilateral initiatives leading to the better use and development of research infrastructures, at EU and international level. Associate country research ministry delegates participate as well.

- The Science and Technology Options Assessment (STOA) unit advises the European Parliament on research related issues.

- In support of its policy formulation remit, the Commission often sets up expert groups which focus on particular European research policy challenges and/or issues such as the Lisbon expert group or the Knowledge for Growth expert group.

- On specific thematic themes relating to research policy there are numerous advisory councils and groups that provide a sounding board for policy and programme development. These include advisory councils which address particular themes or sectors (ACARE-the Advisory Council for Aviation Research & Innovation in Europe; and ERTRAC- the European Road Transport Research Advisory Council), advisory groups for the 7th Framework Programme (FP7) such as ISTAG (Information Society Technologies Advisory Group) and standing committees on thematic issues such as SCAR (Standing Committee on. Agriculture Research).

- There are also permanent expert groups on women in science and ethics.

Apart from these institutions, bodies and fora for discussion among policy-makers, there is also a wide set of other European actors linked to ERA policy-making. Examples are Science Europe, which groups 49 European Research Funding Organisations (RFO) and Research Performing Organisations (RPO), the European University Association (EUA), the European Federation of National Academies Sciences and Humanities (ALLEA), associations of research performing private sector actors, and associations at subnational governance level.

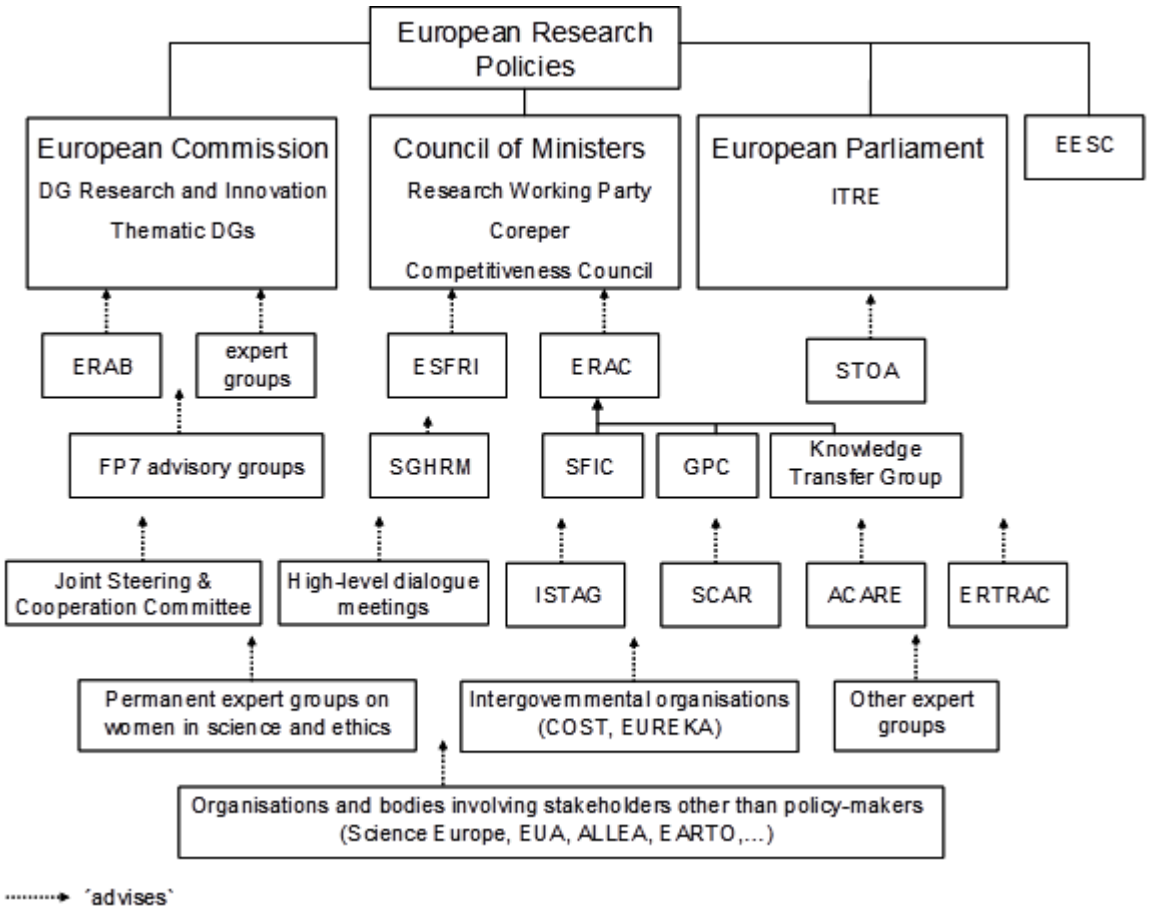


Figure 2 Main European institutions, bodies and discussion fora in European research policy-making1 Source ERAWATCH

Intergovernmental organisations and initiatives shaping the ERA

Inter-governmental initiatives are also critical in shaping the ERA. Due to their nature, they rely upon a high involvement of Member States in their activities and strategy/decision making process. Inter-governmental organizations are in many cases privileged interlocutors between organizations in Member States, Member States and the European Commission. Inter-governmental organisations/institutions and initiatives differ in their scope (consultation, R&D or Innovation funding) as well as their structure and their relationship with the EU. Below we review the main ones:

- The European Technology Platforms (ETPs) are an important example of inter-governmental organizations. ETPs are initiated at the EU level but remain under the control and depend on the initiative of the Member States.
- ERA-nets intend to step up the cooperation and coordination of research activities funded and carried out at national or regional level in the Member States and

Associated States[4]. This is done through EU supported pooling of national funding, resulting in more coordinated programming and research networking at the regional and national scales. This initiative is funded and implemented within the FP7.

- EUREKA is an intergovernmental platform that mobilizes funding to support R&D. This organization was set up by a Conference of Ministers of 17 countries and Members of the Commission of the European Communities in 1985 and since then brings an important number of EU and national Member States representative in its structure. Initiatives such as the EUREKA Clusters, the EUREKA Umbrellas and the EUREKA Eurostar's Programme were all launched by this organisation.

- COST: the European Cooperation in Science and Technology (COST) aims at the reduction of research investments fragmentation in Europe. COST acts in complementarity to the EU Framework Programmes (FPs). This inter-governmental organization is governed by Member States and key decisions are taken at COST Ministerial Conferences, which are held on average every five years.

- European industrial initiatives were initiated by the European Commission and bring together key inter-governmental co-operators based on a similar rationale as in the the ERA-nets. "Teams" have been constituted, with an important involvement of national representatives expected to cooperate. The different European industrial themes covered by the teams are European Bioenergy, CCS, Electricity Grids, Sustainable Nuclear, Solar Industrial, and Wind.

[4] Associates states are countries, outside the EU, that take part to the FP7. They include: Albania, Iceland Israel, Liechtenstein, the Former Yugoslav Republic of Macedonia, Montenegro, Moldova, Norway, Serbia, Switzerland and Turkey.

4 Scientific cooperation with third countries[5]: the international dimensions of the ERA[6]

The recent ERA Communication (EC 2012a) considers international cooperation "a vital, cross-cutting and integral part of ERA"[7]. Similarly the Council of the European Union states, "that international cooperation in research and innovation is vital to the strengthening of the Union's excellence and attractiveness in research and innovation as well as its competitiveness, in tackling global societal challenges, in contributing to the Union's external policies, and that good international relations may, in turn, facilitate effective cooperation in research and innovation" (Council of the European Union 2013). In the past decades scientific production has become increasingly internationalised. Just to give a few figures, 30% of EU overall scientific production (as measured by co-authorship) involves cooperation between researchers from different countries (EC 2012b). Furthermore, R&D investments increasingly follow international trajectories: EU firms invested EUR 13.2 billion in R&D in the USA in 2007, whereas US firms invested EUR 9.5 billion in EU (ibid).[8] The European Commission not only acknowledges the increasing internationalisation of research and innovation (R&I), but actively embraces it with policies aimed at strengthening and harnessing it. In general, two sets of objectives for international science, technology and innovation (STI) cooperation policies can be distinguished. The first are intrinsic in nature and include striving for excellence and improving research systems by increasing cooperation or building infrastructure. The second are extrinsic, in that they focus on the support of other policies e.g. foreign, development or economic policies (EC 2013a). Both of these goals are reflected in the EU's ERA policy. The strategic approach formulated by the EC has three major objectives: to strengthen EUs "excellence and attractiveness in research and innovation as well as its economic and

Third country participation in FP7

141 different third countries have taken part in 6470 FP7 projects. This includes all Associated Countries (AC) as well as the International Cooperation Partner Countries (ICPC) and other third countries, which are not automatically eligible for funding e.g. USA, Japan or Canada(CORDIS 2013).

Switzerland, Norway, Israel and Turkey are the most frequent partners, followed by Russia, USA, China,South Africa, India, Brazil and Australia. (CORDIS 2013).

"About 21% of the signed grant agreements under FP7 had at least one international partner as part of the consortium" (EC 2012b).

Around 2.3% of the total FP7 budget is paid to international partners (EC 2012b).

Some 680 coordinating and support action projects (INCO-Nets, BILATs) facilitate third country participation in the framework programme (EC 2012b).

[5] Third countries are the countries outside FP7 (not MS, nor AC).
[6] In this report, the term international refers to the relationship between the EU and third countries (i.e. countries not associated to the FP7 programme).
[7] This crucial aspect of ERA is only partially covered by priority 2, "Optimal Transnational Co-operation and Competition", described in the following section. This priority is mainly focusing on inner-European transnational cooperation.
[8] This 40% gap is a clear sign of higher attractiveness of USA compared to EU (ibid.).

industrial competitiveness", to tackle global societal challenges, and to support the EU external policies with science diplomacy (EC 2012b).
These objectives are supported through concrete activities, which can take the following shapes (ibid.):

- research and innovation projects where the participation of third country entities is required and/or taken into account during evaluation;
- softer forms of cooperation such as policy dialogue (also important in view of extrinsic objectives and science diplomacy), networking between projects, clusters and/or programme managers;
- joint initiatives involving the Union and international partners (e.g. coordinated calls launched and evaluated in parallel; joint calls launched, evaluated and selected jointly with the partner country; contributions from the Union to funding programmes of third countries or international organisations to cover the participation of EU research entities; specific joint funding initiatives like horizontal ERA-Nets);

In addition to these activities, FP7 mobility schemes (Marie Skłodowska Curie actions) and the European Research Council (ERC) also support international cooperation directly, facilitating inward and outward bound mobility, strengthening ERA's ties with other research areas, and helping to attract foreign talent to the European Union. There is also soft support available for mobility to and from Europe, e.g. via the EURAXESS initiative. The development and support of large-scale and other (e-)infrastructures should also be considered as an activity indirectly supporting international cooperation.
These specific support activities are complemented with, and informed by,; policy dialogue[9] and information gathering, currently supported by specific FP7 schemes like the international cooperation network (INCO-Nets) and BILAT projects[10]. Furthermore, projects under the ACCESS4EU scheme aim to facilitate European participation in other regions' research programmes, whilst ERA-WIDE projects reinforce cooperation with Europe's neighbours. "Research to Innovation" projects (R2I) aim to bridge the gap between research and innovation in an international cooperation setting.
ERA players are also active in coordinating international science collaboration within other policy areas (such as trade, environment, energy), through international forums and agencies like the OECD, UNESCO, FAO or WHO. An interesting initiative for sharing best practices in international collaboration among funding agencies is the recently established Global Research Council, a voluntary forum, which also aims at establishing common principles in internationals cooperation.
The ERA builds on 28 national research systems of Member States whose international research cooperation policies are largely based on national considerations (EC 2012b). Taking this into account and considering the fact that the largest part of R&D funds in the EU are spent at national level, coordination with EU Member State policies and programmes is a crucial part of ERA, also in relation to international cooperation.

[9] The EU currently has S&T Cooperation Agreements with 20 countries; these agreements can help to define and implement the multi-annual roadmaps.

[10] Some of these projects have developed white papers on STI cooperation with the target region.

The international research cooperation activities of EU Member States are coordinated among them and with the EU level in the Strategic Forum for International Cooperation (SFIC) and the High Level Group for Joint Programming described in page 10 above. Coordination of EU MS (internationalisation) activities is also supported by specific Framework Programme projects such as horizontal ERA-NETs and ERA-NET+, which support projects by pooling national and third country funding, supported by EC funds. INCO-LAB and INCO-HOUSE projects have been designed to strengthen European research facilities and S&T centres abroad. These coordination activities allow the EU to present itself as an integrated research area and provide support to the Member States' internationalisation efforts. These instruments are certainly crucial in supporting the internationalisation efforts of smaller MS. However, they are also extremely important for the most active MS in international STI collaboration, such as France, Germany or UK.

As well as the coordination of national efforts at the EU level, the internationalisation strategy for ERA also calls for "national systems [to] be more open to each other and the world" (EC 2012a).

This is critical given that 85% of all public research and development funding, programming, monitoring and evaluating in the EU is processed at the national level. Indeed, MS put in place various actions geared towards the internationalization of STI. Some MS have an explicit internationalisation infrastructure and strategy, some do not. [11]

MS' internationalisation activities tend to have a geographical, rather than thematic, focus. USA or Japan, Canada, Israel, with highly developed STI systems, have the highest priority for cooperation, but BRIC-countries (Brazil, Russia, India and China) are also a common cooperation focus (as their strong growth makes them interesting as emerging markets), as well as newly emerging economies. Some MS have development cooperation aspects as policy goals for STI cooperation targeting mostly African countries (for instance improving health care in Uganda with funds from Medical Research Council UK).

Thematic priorities are rarely specified by MS and, when they are, they vary broadly in their level of specificity. Often, they are linked with certain domains or challenges e.g. ICT, Nanotechnology, Health, Sustainable development or Biotechnology (EC 2013a).

The STI internationalisation model of the European Union

When comparing the EU's model of STI internationalisation to that of other regions, one of the major characteristics in ERA is the support of research performed in large, multinational consortia within and beyond Europe. This is generally speaking different from the way US funding agencies publicly support research. A second peculiarity is the opening of the research programme with funds flowing to research partners outside the EU Member States and countries associated to the Framework Programme.

Recent years have seen a response to this principle of opening. For instance, Russia and China have started opening national funding programmes for EU-based researchers who are currently able to participate and receive funding from these programmes.

This opening of funding is significantly different from other approaches like funding of joint research where Calls and programmes may be coordinated, but where each side pays its own share (and researchers). While FP7 also used this mode of internationalization (through coordinated or joint calls) on occasions, this is the dominant rationale for STI cooperation in Japan and the US.

[11] However, the absence of a national internationalisation strategy does not imply that internationalisation activities of the given country are weak. Rather, the existence of an explicit strategy can be considered an indicator of the importance of STI cooperation at the policy level (EC 2013a).

The STI internationalisation policies of MS are implemented by a set of policy measures and instruments, which are often focused on activities with other EU MS but remain open for third countries. The number of instruments specifically aimed at stimulating STI cooperation with third countries usually involves a selection of the following (ibid.):

- A number of EU MS open up their national research programmes and grants for researchers from abroad.
- Bilateral agreements and Memoranda of Understanding (MoU) made at the level of ministries, agencies or universities.
- Multilateral agreements and programmes such as programmes of international organisations like OECD, G8/20, NATO or UNESCO.
- Mobility schemes open to third country participants, promoting inward and/or outbound researcher mobility. The MS' mobility programmes differ greatly from each other in terms of funding level, supported length of stay, targeted countries and integration in larger partnership programmes.
- Bilateral and, on occasions, multilateral partnership programmes encompassing: joint committees or expert groups, joint research activities, activities to attract researchers and business to a country, activities to improve the quality of RTDI systems in third countries, dialogue between countries; knowledge transfer in the broadest sense. Often these partnership programmes are developed as part of a wider S&T agreement that exists between countries.
- Foreign branches or subsidiaries of EU MS, their agencies and institutions are increasingly established in third countries. They function as a gateway for technology transfer and aim at increasing national competitiveness, knowledge-exchange and S&T capacity building. The most common form of foreign branches for EU MS is the S&T liaison offices linked to the embassies. These liaison offices support S&T networking, knowledge exchange and business development and are mostly focused on the BRICs, USA and Japan.

4.1 International Scientific Cooperation in the 2014-2020 Multiannual Financial Framework

Beyond the funding and above mentioned coordination aspect, the EU has identified several important steps that can maximise the benefits from international STI cooperation: developing a common EU-MS strategy for international STI cooperation, reducing the fragmentation of the European market, improving employment and career prospects for researchers, etc (EC 2012c). Horizon 2020 takes some steps towards this direction, confirming the commitment to international cooperation, fostering networking and collaborative research, whilst streamlining and simplifying rules for participation. An important witness to this commitment is the so called principle of general opening. This refers to the fact that partners from around the world can participate in Horizon 2020. Partners from developing countries and emerging economies also qualify for automatic funding, i.e. they can receive Framework Programme funding and the same rules apply than in the case of European partners. Partners from highly developed economies and BRICS, which received automatic funding in FP7, receive funding only in case their participation can be justified as being crucial to the success of the consortium. In parallel to that, an increasingly important

guiding principle is reciprocity, according to which"[T]here should be similar access for European researchers to the R&D programmes of third countries as there is for third-country researchers to European programmes" (EC 2012c).
Horizon 2020's stronger focus on societal challenges can also be read as a very deliberate acknowledgement of the need for cooperation within and beyond Europe: solutions to these challenges can only be found collaboratively and by jointly investing sufficient resources in a coordinated fashion.
In order to ensure coordinated planning and spending, multi-annual roadmaps will be developed for cooperation with key partner countries and regions. Such roadmaps require an important intelligence gathering exercise. Data on impact of international cooperation activities, as well as policies by the EU, Member States, Associated and Third Countries needs to be collected. Foresight activities are vital for identifying emerging challenges and future markets (EC 2012b). Areas for engaging with third countries will be systematically identified and incorporated into Horizon 2020 work programmes (including Euratom[12]), both thematically and through specific support activities which will operationalise and implement the multi-annual roadmaps. To take these steps, it is necessary to involve the main stakeholders in all the planning, coordination and implementation processes.
In Horizon 2020, international cooperation will also have a focus on close-to-market and other innovation related activities, which was formerly handled outside the Framework Programmes (by the CIP and EIT which are now integrated into Horizon 2020). Keeping the balance between cooperating with third countries and safeguarding the interests of the EU companies is therefore important.

As part of its internationalisation strategy, the EU also envisages intensifying the engagement with international organisations such as OECD, UNESCO or IAEA or ITER. It plans to give these organisations a stronger voice in shaping the EU agenda whilst providing the EU with greater influence on their activities, particularly where the Union is a major donor and/or member (EC 2012b).

To sum up, a number of actions are in place to strengthen and improve the EU's and its MS' international R&I cooperation. In Horizon 2020, the general opening principle persists, but with a more focused approach and efforts towards reciprocal opening of funds. Science, technology and innovation funding on the EU level is streamlined through the combination of the Framework Programme for Research and Technological Development with the Competitiveness and Innovation Framework Programme and the European Institute of Technology, resulting in a more coordinated internationalization of European-level innovation activities. Pooling and coordination of European Member State funding through instruments like thematic ERA-Nets, Joint Programming Initiatives, etc., is likely to involve an increasing number of third country partners. Often, these instruments can build on existing bilateral or multilateral programmes, which makes them useful vehicles for outreach to partner regions. Through the

[12] The European Atomic Energy Community (Euratom), established through the Euratom Treaty, receives funds from EC's Framework Programmes for nuclear energy research (in addition to proper funds). Regarding cooperation with third countries, Euratom research funds are not automatically available for third countries. However, the planning for international cooperation in the form of the multi-annual roadmaps will also apply to Euratom and will be visible in the Euratom work programmes of Horizon 2020.

development of multi-annual roadmaps, future coordinated planning in cooperation with key partner countries will be ensured and will assist to increase the global attractiveness of Europe as a location for excellent research and as a preferred cooperation partner in science, technology and innovation.

5. A deeper look at the Five ERA Priorities

This section provides a deeper look at each of the five ERA priorities, describing them in three sections:

What it is about – this section provides an overview of the issues that each priority tackles. In other words, it highlights why the priority itself is relevant to the scientific, social and economics development of the European Union. Through this information, we are then able to introduce the key actions foreseen by the EU-ERA Communication (2012a).

Where we are now – this section provides an assessment of the progress made by the EU. It highlights the role of MS and EU under each priority and then, identifies the key EU instruments relevant to the priority.

Where we are going – this section reviews the key EU-level documents with RTI relevance related to the multiannual financial framework 2014-2020, highlighting how they relate to each specific priority. In particular we review the following documents:

> **Europe 2020 Strategy** (EC 2010a, 2010b, 2010c, 2010d, 2010e, 2010f, 2011a): Europe 2020 is the European Union's ten-year growth strategy, which relies heavily on research and innovation, as drivers of growth. The strategy is structured in seven 'flagship initiatives' under three objectives: smart growth, sustainable growth, and inclusive growth. These are, for the smart growth objective: Digital agenda for Europe, Innovation Union, Youth on the move; for the sustainable growth objective: Resource efficient Europe, An industrial policy for the globalisation era; for the inclusive growth objective: An agenda for new skills and jobs, European platform against poverty.[13]
>
> **Horizon 2020 (EC 2011b):** Horizon2020 is the financial instrument implementing the Innovation Union (IU), one of the Europe 2020 flagship initiative. The IU aims at securing Europe's global competitiveness, combining research and innovation funding, the innovation related activities of the Competitiveness and Innovation Framework Programme (CIP) and the European Institute of Innovation and Technology (EIT).
>
> **Structural and Cohesion Funds:** The **Structural Funds and the Cohesion Fund** are financial tools set up to implement the regional policy of the European Union. They comprise European Regional Development Fund (ERDF) and the European Social Fund (ESF). They represent the main instrument for supporting the key priorities of the EU as highlighted in the Europe 2020 strategy, including those relevant to the ERA. The ERDF, in particular, supports regional and local development by co-financing investments in R&D and innovation; climate change and environment; business support to SMEs; services of common economic

[13] The interested reader is referred to the first edition of the ERA Fabric Map for further information on the links between the Europe 2020 Strategy and the ERA.

interest; telecommunication, energy and transport infrastructures; health, education and social infrastructures; and sustainable urban development.

Wherever other documents affect individual priorities, they are also reported.

5.1 Priority 1: More effective national research systems

5.1.1 Pr.1-What it is about

Compared to its main competitors, the European Union underperforms in terms of R&D funding and scientific output, while having a very heterogeneous RDI landscape. Furthermore Europe faces a series of significant challenges, such as the economic and financial crisis, low growth, ageing population, etc. Recognizing that Europe's future growth relies to a large extent on R&I, the European Council reaffirmed in March 2010 that the overall R&D investment level should be increased to 3% of EU GDP as part of improving the conditions for research and development. Despite that, in the context of the economic crisis, public effort in the European Union on research (measured as the share of total general government expenditures allocated to GBAORD) has been declining in relative terms since 2009. Furthermore, wide disparities in GBAORD are observed across EU, with knowledge production being concentrated in a relatively small number of MS (the three leading MS in terms of GBAORD— Germany, France and the UK — accounting for more than half of the total GBAORD, concentrate 10% of the production of the most cited publications).

National research performers across EU have access to very different level of public funds for R&D, which are dispersed to the R&D performers through various mechanisms. These two factors increase the divergences in performance across the EU. The variety of national approaches to competition for funding is one of the underlying 'structural' breaks which do not allow the development of adequate framework conditions for research and innovation at national and European level.

There are two main allocation mechanisms of public funds: institutional (general/block) and project funding.

- **INSTITUTIONAL FUNDING** (general/block) are attributed directly and globally to institutions such as universities or public research institutes. Such funding is provided through various distribution algorithms, which may include a share based on institutional performance assessments. In general, the repartition of funds and the research to be carried out are at the discretion of the institute receiving the funds.

- **PROJECT FUNDING** - Broadly defined as money attributed through an open and competitive process to a centre, group, or individual to perform a research activity limited in scope, budget and time. Public project funding is made available through specific instruments directly to individual researchers or research units (rather than channelled through large research organizations) (Lepori et al. 2007). In organisational terms, the decisive feature of project funding is the existence of dedicated institutions (agencies, academies or councils) external to the central administration, selecting the project to be funded and allocating money to a research group.

There is academic evidence that excellence in science is linked to competition between researchers and evaluation of scientists evaluated through comparable international.

The literature also demonstrates a clear link between a more competitive funding environment for universities and the productivity of the whole research system in terms of the number of publications per euro invested (Auranen and Nieminen, 2010).[14] Among the most important factors to be considered are:

- **Selectivity**: competitive funding is generally concentrated in a set of predefined set of priorities, generally with potential socio-economic impact, while investigator driven research is much less funded.
- **Concentration**: funding is concentrated on the best performers.
- **Sustainabilit**y: competitive funding may give the provision for long term growth.

Within this context, in the EC 2012 communication, EC invites National authorities of Member States to:

- Introduce or enhance competitive funding through calls for proposals and institutional assessments as the main modes of allocating public funds to research and innovation, introducing legislative reforms if necessary.
- Ensure that all public bodies responsible for allocating research funds apply the core principles of international peer review (excellence, impartiality transparency, appropriateness of purpose, efficiency, speed, ethical and integrity, evaluation is performed by independent national and international experts.
- On the other hand, the commission will support mutual learning and the exchange of good practice between MS, support MS and regions in using Structural Funds to develop research capacity and smart specialisation strategies and support ERA Chairs aimed at fostering structural change in institutions to raise their research quality to international levels of excellence

5.1.2 Pr.1-Where we are now

R&D statistics are basically concerned with the detailed measure of R&D expenditures and their breakdown by performers, funders and sectors, and is largely disregarding the instruments and allocation mechanisms (Lepori, 2006). Systematic and comparable information across countries on the quantitative importance of the different instruments has been lacking (the PRIME project is the first experiment on quantitative assessment on changes in allocation mechanisms). Consequently, a quantitative analysis of allocation modes/funding instruments is still not yet in place. It is thus only possible to provide a broad description and highlight some key trends.

Total Government Budget Appropriations or Outlays for R&D (GBAORD) in the EU have declined in relative terms since 2009, to reach 0.72% of Gross Domestic Product (GDP) in 2011. In the context of continuous pressure on national R&D budgets, structural reforms should aim to use more efficiently the resources and therefore maximise the return on investment in research.

All countries allocate research funding through competitive calls for projects and this share shows an increasing trend. However the exact proportion is not available through

[14] However, other studies have shown that while increased competition is associated with higher performance levels, the underlying situation is complex and includes other incentives and environmental factors (Tsipouri et al. 2013).

official sources. Work by the OECD (2012) and the JRC-IPTS (Doussineau et al. 2013) has indicated that the share of competitive funding as a total of public R&D funding (GBAORD) varies from 20% to 80% among Member States with an average of about 40%.
The increased role of EU funding schemes in some countries triggered the increase of the competitive funding share, indeed the high monitoring and evaluation requirements related to EU funding have some leveraging effects on national efforts, both in terms of the quality of the knowledge base as well as evaluation practice.
Few countries have shifted relative focus from direct funding measures to indirect R&D finance and include loans or credit for businesses, or the extension of tax credit schemes for R&D activities. Tax and risk capital related policies, targeting the financing of innovation and entrepreneurship, have experienced a certain boom due to the crisis: *governments more willing to temporarily share risks* with businesses (Chioncel and Cuntz, 2012a, 2012b).
Allocation of funds based on regular, efficient, transparent institutional assessment is at an early stage or moderately developed in most of the countries. Countries where the culture of evaluation is relatively advanced (UK, SE, DK, FI, DE) continue on a learning track, expanding practices with respect to systematic evaluation approaches. In many countries, new funds distribution models have been recently adopted, and these include research performance indicators, besides education/ staff based appropriations. While the general aim is the promotion of excellence, the specific approach varies between Member States. This includes advancements in evaluation practices and efforts to introduce new, related institutional arrangements and undergoing reforms. Such reforms frequently face stakeholder resistance, lobbying efforts and, consequent delayed implementation (Doussineau et al, 2013).
In most of the countries, there are provisions for using the core principles for international peer review, yet the formal compliance to the rules vary. In few countries, there is a formal and explicit request for the involvement of a certain share of international reviewers (particularly in the new Member States adopting new schemes, redesigning the R&D funding system). In the countries with tradition in evaluation, although the core principles of peer review are generally applied and the involvement of international experts may be requested, there is no explicit and formal request for it. "Appropriateness" (relevance), "excellence", "ethical and integrity" criteria are used more systematically in the evaluation of proposals.
The share of competitive funding and of performance based institutional funding shows an increasing trend in Europe. In many countries there are formal provisions for the application of core principles of international peer review.

5.1.3 Pr1- Where we are going

Table 1 – Priority 1 – Where we are going

EC Policy	How it relates to the priority
Europe 2020 Strategy	Knowledge and innovation are at the core of the growth strategy of Europe2020. The EU target of investing 3% of GDP in R&D is one of the five main targets of EUROPE 2020. This ERA priority, since refers to RDI funds allocation, is impacting all the other ERA priorities and is reflected explicitly or implicitly in many of the EC policies. The **innovation Union Flagship initiative** is the most relevant to this ERA priority, as it focusses on enhancing R&D and innovation. MS are invited to carry out self-assessments, identify key challenges and to

	reform national (and regional) RDI systems to foster excellence and smart specialisation, reinforce cooperation within Knowledge Triangle, implement joint programming and adjust national funding procedures accordingly. MS are encouraged to prioritise knowledge expenditure, including by using tax incentives and other financial instruments. The flagship initiative **Youth on the Move** is relevant to this ERA priority, since it aims to enhance the performance and international attractiveness of Europe's higher education (HE). At EU level, the EC will work to step up the modernisation agenda of HE (curricula, governance and financing) including by benchmarking university performance and educational outcomes. MS are asked to ensure efficient investment in education and training systems, addressing each segment within an integrated approach. The Knowledge Triangle policies and funding are an important component of this flagship initiative and an essential component of ERA Priority 1. **Flagship Initiative: "A Digital Agenda for Europe"** Various actions foreseen under this initiative affect the implementation of ERA Priority 1. Among them the access to a stable legal framework that stimulate investments in an open and competitive high speed internet infrastructure, targeted R&D funding in pursuit of this agenda, increase support in the field of ICTs are the most important. The deployment and usage of modern accessible online services can support online research applications and evaluations, simplify and speed up procedures. **Flagship Initiative: "Resource efficient Europe"**. The aim of this initiative is to support the shift towards a resource efficient and low-carbon economy. Public and private, national and EU financial instruments must be mobilised (e.g. structural funds, national R&D funds) as part of a consistent funding strategy. This will imply thematic R&D funding, with appropriate (competitive) allocation modes. **Flagship Initiative: "An industrial policy for the globalisation era"**. The EC will work closely with stakeholders in different sectors to draw up a framework for a modern industrial policy, to support entrepreneurship, to enforce the intellectual property, to improve the business environment especially for innovative SMEs. These actions will imply funds targeting the knowledge transfer measures, the design of improved intellectual policy framework. **Flagship Initiative: "An Agenda for new skills and jobs".** The aim of this flagship initiative is to create conditions for modernising labour markets, empowering people through the acquisition of new skills, raise labour productivity. Higher and more efficient investment in RDI can trigger higher productivity, acquisition of research skills adapted to industry.
EC Funds and Regional Policy	EU funding has direct impact on this priority, explicitly and formally addressing the need of smart, efficient allocation of funds. The principle of partnership and multi-level governance, at the core of EC Funds, requires coordinated action carried out in accordance with the principles of subsidiarity, proportionality and in partnership. Indded, EC and MS must work together to strengthen the coordination and complementarities between the CSF Funds and Horizon 2020, the

	Programme for the Competitiveness of Enterprises and small and medium-sized enterprises (COSME), and other relevant national funding programmes while establishing a clear division of areas of intervention between them. In particular, MS are requested to develop national and/or regional R&I strategies for 'smart specialisation'. These strategies shall be developed through involving national or regional managing authorities and R&I stakeholders. This new innovation policy concept has been designed to promote the efficient and effective use of public investment in research. Its goal is to boost regional innovation in order to achieve economic growth and prosperity, by enabling regions to focus on their strengths.
European Regional Development Fund	The EC proposed a number of important changes to the way cohesion policy is designed and implemented: concentrating funding on a smaller number of priorities better linked to the Europe 2020 Strategy, focusing on results, monitoring progress towards agreed objectives, increasing the use of conditionalities and simplifying the delivery. The Regulation determines the scope of intervention of the ERDF, defining the share for each of the thematic objectives. The instruments attached have specific allocation modes, generally involving project competition. The need of coordination between ERDF, SF in general, and national funds put pressure for aligning national funding with specific priorities.
Horizon 2020	All policy instruments and measures in Horizon 2020 are explicitly designed to contribute both to research and innovation and the development of the ERA. Horizon 2020 will focus resources on three distinct, yet mutually reinforcing, priorities: Excellent Science, Industrial Leadership, and Societal Challenges. All three priorities are directly impacting the RDI funding at national level. Programmes committees are aimed to ensure links to nationally funded activities. The structural simplification proposed under Horizon 2020 can have a leverage effect on national funding.

5.2 Priority 2: Optimal transnational co-operation and competition

5.2.1 Pr.2-What it is about

This second priority combines elements from several of the former ERA dimensions (dimension 2 on developing world-class research infrastructures, dimension 5 on optimising research programmes and priorities, and dimension 6 on international cooperation in S&T which is now cuts across all priorities).

Europe 2020 assigns two roles to research in Europe: solving societal challenges[15] and increasing competitiveness. As the European research landscape is highly fragmented, coordination efforts are being made in order to create critical mass, avoid duplication and identify gaps. These engage stakeholders from both the public and the private sectors in identifying and responding to Grand Challenges in transparent processes taking into account the global dimension. In addition, Europe 2020 points at two other

[15] The need for European research to focus on the Grand Challenges of our time and moving beyond current rigid thematic approaches is also recognised by the 2009 Declaration of The Lund Conference, subscribed to by 350 researchers, funders, business representatives and politicians at the Swedish Presidency's New Worlds New Solutions conference in July 2009 and acknowledged by the Council ftp://ftp.cordis.europa.eu/pub/sweden/presidency/docs/lund-declaration_en.pdf

aspects relevant to this priority: the need to 'reform national (and regional) R&D and innovation systems to foster excellence and smart specialisation'. One way to foster excellence is by optimising competition (e.g. through joint calls triggering European-wide competition among research consortia instead of purely national competition), which is also part of this priority.

In essence, optimal transnational cooperation and competition could relate not only to research programme coordination and research infrastructure cooperation, as currently described in the ERA Communication 2012, but also to other types of cooperation, both in research and in innovation. Examples include institutional cooperation and the creation of joint institutes (such as CERN[16]) or cooperation between innovation clusters and aligning cluster policies (e.g. Europe Innova focusing on joint policy learning with regard to innovation clusters), thus widening the priority area to not only include research but also innovation. Complementing the ERA Communication of the Commission, the Council of the European Union (2012) follows this line by stressing the 'need to enable transnational research *and innovation* by fostering and exploiting synergies between national programmes with *international* programmes'. Taking into account these aspects this priority can be understood in a broad sense as 'optimal transnational and international R&D cooperation and competition'. Transnational cooperation then refers to cooperation between EU MS, while international cooperation refers to cooperation with non-EU countries (both Associated States and Third Countries).

Based on the need to address Grand Challenges, the 2012 ERA Communication urges Member States to act coherently to achieve the scale of effort and impact needed to address these grand challenges with the limited public research funds available. Synergies and reinforced interoperability between national research systems in terms of strategic agenda, research infrastructures but also processes are the backbone for "Optimal transnational co-operation and competition". This priority has been operationalised in two main parts: programme cooperation and research infrastructure cooperation.

1. Optimising transnational programme cooperation and competition

The optimisation of transnational (and international) programme cooperation has, according to EC (2012a), a threefold objective, at member States level, at Stakeholders level and at EC level:

Member States are invited to step up efforts to implement joint research agendas addressing grand challenges (including information sharing, strategic alignment of national funding at European level and common ex post evaluation), ensure mutual recognition of evaluations that conform to international peer-review standards as a basis for national funding decisions, and removal of legal and other barriers to the cross-border interoperability of national programmes (including cooperation with non-EU countries where relevant).

Stakeholder organisations are encouraged to agree on common funding principles, to further develop and deploy the Lead-Agency, Money-Follows-Cooperation Line, Money-Follows-Researcher and other models for cross-border cooperation and to pilot the use of synchronised calls with, where possible, single joint international peer review evaluation of proposals as a basis for funding decision.

[16] European Organization for Nuclear Research

Meanwhile, EC is engaged to pursue, stimulate and participate in Public-Public Partnerships to address grand challenges as set out in the Communication on Partnering in Research and innovation to leverage Member States' contributions and ensure close coordination with relevant activities under Horizon 2020, map activities in agreed priority areas, with a view to identifying strengths, weaknesses, gaps and duplications.

2. Creating pan-European Research Infrastructure.
The 2012 ERA Communication mentions that Member States should confirm (the Council talks about '*renew and adapt'*) their financial commitments for the construction and operation of ESFRI, global, national and regional RIs of pan-European interest and to remove legal and other barriers to cross-border access to Research Infrastructures.
From the EC side, access to Research infrastructures and overall integration is supported notably Infrastructures awarded by the ERIC[17] status. The EC encourages Member States to link their national roadmaps to the ESFRI roadmap and smart specialisation strategies in Structural Funds co-financed research and innovation programmes, reinforcing the capacity of less favoured regions to host and participate in RIs of pan-European and international interest.

5.2.2 Pr.2-Where we are now

1. Optimising transnational programme cooperation and competition
1.1 The wider context of priority setting towards societal challenges
The main questions in this context are: Who decides on the priorities? And which priorities get most funding? Obviously, both questions are connected as priorities in public R&D are normally set by those who spend the budget. As public R&D budgets in Europe are largely dispersed, also the setting of priorities is largely fragmented. When policies aim to include more societal challenges in priority setting, it is important to understand well this fragmentation. Figure 1 below shows the different levels at which societal challenges are (sometimes partially) being used to set public priorities in research and innovation. The table gives an overview of societal challenges set at European, national and regional level. The sum of all these priorities could be considered as the priorities for the EU as a whole. The last column of the table shows an attempt to summarise those priority challenges for Europe. In practice, priorities for Europe may however differ from this list of summarised priorities for several reasons, such as:

- The summary does not take into account all the details of each priority at each level
- The final resulting challenges depend on the relative weight (the budget allocated to it) for each priority at each level.
- National and regional priorities that are not linked to JPIs are specified in this overview. The majority of the budget is, however, decided on at these levels. The same goes for priorities set by other organisations such as universities and public research organisations (PROs).

[17] The Community legal framework for a European Research Infrastructure Consortium (ERIC) entered into force on 28 August 2009. This specific legal form is designed to facilitate the joint establishment and operation of research infrastructures of European interest.

Below we briefly address priority setting at national and regional level and by universities/PROs.

1.2 Transnational cooperation towards societal challenges

With regard to the national level, high R&D spending countries seem to have a clear orientation towards grand challenges, albeit in different ways. EU-12 seems weakly connected to grand challenges, apart from Poland, Czech Republic and Estonia. With regard to coordination, 4.27% of total GBAORD (EU28+NO+CH) or €4.2 billion is spent in a transnationally coordinated way, of which two thirds represent national contributions to ESA. Without ESA contributions the share of transnationally coordinated R&D budget represents only 1.47%, out of which two thirds are accounted for by only four countries (DE, FR, UK, IT) (Doussineau et al, 2013). For EU27 €257 million of national R&D funds have been committed for ERA-NET and ERA-NET Plus joint calls (excluding the top-up funding of the EC), or 0.28% of 2010 GBAORD. This raises the issue of how the majority of national public funding of transnationally coordinated research is spent. According to Eurostat, three categories of R&D performers and programmes are involved:

- Transnational public R&D performers located in Europe, such as CERN, ESO or the JRC
- Europe-wide transnational public R&D programmes: this includes ERA-NETs and ERA-NET+, but also EUREKA, COST, ESA, EFDA, EUROCORES, Article 185 initiatives, Joint technology initiatives (public funding part: ENIAC, ARTEMIS). In terms of budgets, national contributions to the European Space Agency (ESA) represent the big majority and represent €2.6bn for EU27 in 2010 (€2.9bn for EU27 in 2013 – Source: ESA).
- Bilateral or multilateral public R & D programmes established between Member State governments (and with candidate countries and EFTA countries)

Looking at programme coordination over time, Bertrand and Niehoff (2013) estimate that the total public funding of research implemented by ERA-NETs, ERA-NET Plus and JPIs between 2004 and 2012 amounts to more than €2 Billion. Based on planned calls for the period 2013 – 2015, they estimate that between €845 Million and €1.2 Billion coordinated spending of public funding is currently being expected between 2013 and 2015. This represents an increase in the total amount spent through joint calls, but in relative terms, the amounts stay very low compared to total GBAORD. As for JPIs, which aim to address grand challenges, four out of ten have adopted a Strategic Research Agenda and six have implemented or plan to implement joint calls (representing between €300 and €350 Million per year in 2011 and 2012, and expected to reach more than €450 Million in 2013). Without giving a clear target for the share of GBAORD transnationally coordinated, the EC 2012 Communication stated that the level of alignment was too low to have a serious impact on big and complex challenges. Under unchanged conditions this is not likely to change drastically.

With regard to the regional level the European Commission wants regional (and national where relevant) authorities across Europe to develop R&D strategies for smart specialisation, as an ex-ante conditionality to make use of the EU's Structural Funds. Regions are currently in the process of devising those strategies. Such strategies are seen to also contribute to addressing societal challenges. The size of available R&D budgets at regional level is currently unknown.

In the European policy debate universities are also seen to have an important role in addressing societal challenges. Based on a 2011 survey by JRC-IPTS among rectors and vice-rectors of research-intensive universities across Europe it appears that universities

address a wide variety of challenges related to all priorities of Europe 2020. In the same survey also concerns were expressed about the position of basic science vis-à-vis challenge-oriented research.

Figure 3 Research priorities targeting societal challenges at different levels, and estimation of resulting priority societal challenges for the EU as a whole. SOURCE: IPTS based on EC official documents

Research priorities targeting societal challenges at different levels							Resulting priority societal challenges for the EU
European level				National level		Regional level	
Europe 2020 (3)	Horizon 2020 (7)	KICs (3+6)	EIPs (3+2)	JPIs (10)	National strategies	Regional strategies	
Inclusive growth	Health, demographic change and wellbeing	Innovation for healthy living and active ageing	Active & healthy ageing	Neurodegenerative Diseases A Healthy Diet for a Healthy Life More Years, Better Lives Antimicrobial Resistance	Majority of public R&D funding		Health & well-being
Sustainable growth	Food security, sustainable agriculture, marine and maritime research, and the bio-economy	Food4Future	Agricultural sustainability & productivity Water	Agriculture, Food Security & CC Water Challenges for a Changing World Healthy and Productive Seas and Oceans			Food, agriculture, water
Sustainable growth	Secure, clean and efficient energy	Inno-Energy					Energy
Sustainable growth	Smart, green and integrated transport	Urban Mobility	Smart cities & communities	Urban Europe			Transport & cities
Sustainable growth	Climate action, resource efficiency and raw materials	Climate		Connecting Climate Knowledge for Europe			Climate change
Inclusive growth	Inclusive, innovative and reflexive societies			Cultural Heritage and Global Change			Inclusiveness & learning from history
	Secure societies	Secure societies					Security
		Raw materials	Raw Materials				Raw materials
Smart growth		Added Value Manufacturing					Manufacturing

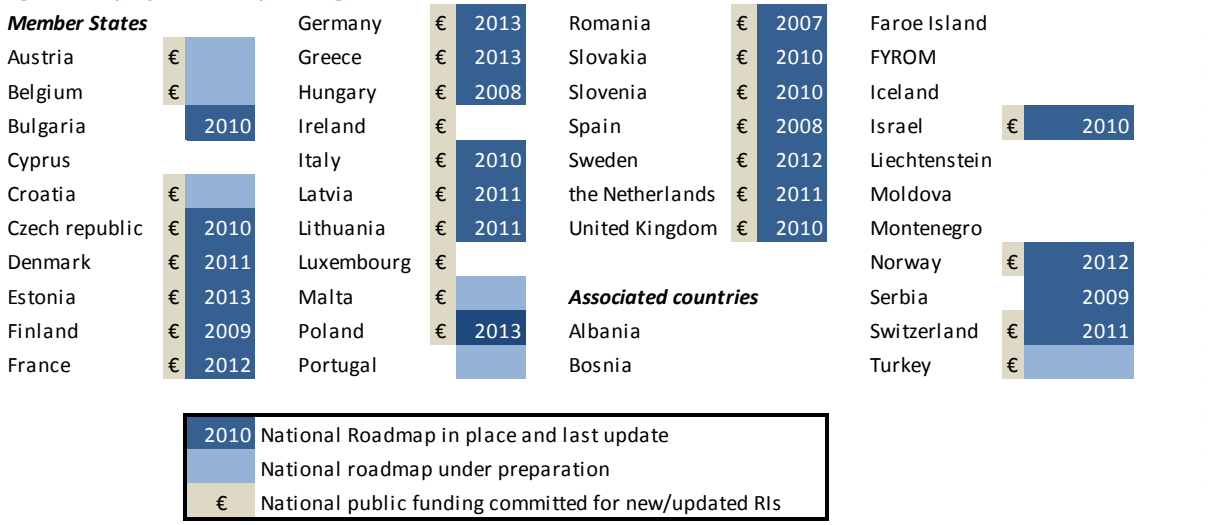
2. Research infrastructures

Regarding Research infrastructures, ESFRI's mandate has been expanded by the Council in December 2012. In its *Conclusions on a reinforced European research area partnership for excellence and growth*, the European Council endorsed the need for a strengthened partnership in the field of research infrastructures and "for renewing and adapting the mandate of ESFRI to adequately address the existing challenges and also to ensure the follow-up of implementation of already on-going ESFRI projects after a comprehensive assessment, as well as the prioritisation of the infrastructure projects listed in the ESFRI roadmap." The main task of ESFRI is now to help its projects follow the roadmap move towards implementation.

As far as research infrastructure is concerned, the 2010 ESFRI annual report (ESFRI, 2011) listed 52 infrastructure projects co-funded by EC and Member States, Associated and Third Countries (Switzerland and Canada contribute significantly). Coordinated support policies towards RI are encouraged notably with the design of national RI roadmaps linked to the ESFRI roadmap. In 2012, most of the EU countries have developed national roadmaps and are financially committed to ESFRI projects but it

seems still too early to envisage synergies between national, European and structural funds. European regions are developing their Smart specialisation strategies which are encompassing the dimension of research infrastructure.
The current deployment or planning of research infrastructures by Member States and Associated Countries is shown in figure 4 below. The assessment shown in the graph is based on ESFRI information, FP7 contracts database (regarding financial commitment in ESFRI) and contributions from independent experts from Member States and associated countries. Almost all Member States have developed or are developing national roadmaps (Cyprus, Luxemburg and Ireland are the exception) and are financially committed in ESFRI infrastructures at different degree. Among the Associated Countries, Norway, Serbia, Israel and Switzerland have developed national roadmaps, and will soon be followed by Israel and Turkey (the national roadmap was still under preparation by the Ministry of Development in 2012). Among Associated countries, only Norway, Serbia, Switzerland, Israel and Turkey have developed or are developing national roadmaps.

Figure 4 Deployment and planning of Research Infrastructures for EU members States and associated Countries



Based on ESFRI assessment and updated by JRC-IPTS based on independent expert contributions
Source: ERA Communication Synthesis Report (Doussineau et al., 2013).

Since the last update of ESFRI roadmap in 2010 and the ERA communication 2012, most of the Member States have published or updated their national roadmaps. The creation of a new legal status (ERIC) aiming at facilitating transnational cooperation between countries is implemented in 11 Research infrastructures.
The 2010 ESFRI roadmap provides a list of 48 research infrastructures that [18] received both an EC contribution from EU FP7 and national public funding in their preparation phase. National authorities of Member States but also Associated and Third Countries are committed to the preparation and implementation of those infrastructures. A rough indication of the involvement of MS in this priority can be achieved by looking at their financial commitment in the preparatory phases of the aforementioned 48 RI projects funded by under FP7[19]. The latter shows that 27 of the 28 member states are financially committed in at least one infrastructure projects. Furthermore it shows an unbalanced distribution among countries with 80% of the total financial commitment representing 5 countries (UK, FR, DE, IT, NL). As this relates only to the preparatory phase, this

[18] Strategy Report on Research Infrastructures Roadmap 2010-European Strategy Forum on Research Infrastructures (ESFRI)
[19] For calculations and comparison, we have used the FP 7 contract database - October 2012 version

picture of financial commitment comes with an important caveat: financial commitments can change drastically when RIs move towards implementation.

5.2.3 Pr.2-Where we are going

Table 2 – Priority 2 – Where we are going

EC Policy	How it relates to the priority
Europe 2020 Strategy	*Jointly addressing grand challenges: optimal Transnational activities* 'The innovation Union Flagship initiative is the most relevant to this ERA priority, as it focusses on optimising transnational cooperation. EC will complete the European Research Area, to develop a strategic research agenda focused on challenges and to enhance joint programming.' 'Member states are invited to reform national (and regional) R&D and innovation systems to foster excellence and smart specialisation, reinforce cooperation between universities, research and business, implement joint programming and enhance cross-border co-operation and adjust national funding procedures accordingly.' *Research infrastructures* 'RIs are not mentioned explicitly in the Europe 2020 strategy but the 2010 ESFRI roadmap makes the links with a vision for 2020[20]. According to ESFRI roadmap Research Infrastructures contribute to the implementation of the Europe 2020 strategy and its Innovation Union Flagship Initiative and enable the building up of the European Research Area. They also support the Joint Programming Initiatives by providing researchers with excellent research platforms dealing with pressing societal challenges.'
European Regional Development Fund	*Jointly addressing grand challenges: optimal Transnational activities* 'Optimisation of transnational activities is not directly covered by the Common General Provisions Regulation for the EU funds, which encourage synergies between different instruments and sources of funding to be taken into account and exploited. The Cohesion and Social Funds may be used to support financial instruments. Financial instruments may be combined with grant, interest rate subsidies and guarantee fee subsidies. *Research infrastructures*' 'As ex-ante conditionality to access the funds, member states has to adopt a multi-annual plan for budgeting and prioritization of investments linked to EU priorities (European Strategy Forum on Research Infrastructures -ESFRI).'
Horizon 2020	*-Jointly addressing grand challenges: optimal Transnational activities* 'Horizon 2020 proposes a challenge-based approach bringing together resources and knowledge across different fields, technologies and disciplines. This target implies national policies alignment (strategies, funding procedures etc.)' *-Research infrastructures* 'One of the priorities of Horizon 2020 is "Excellent Science", which is directly relevant to the creation of world-class research infrastructures (including e infrastructures) accessible to all researchers in Europe and beyond. ESFRI proposes in its 2010 roadmap a focused and ambitious vision for 2020 to meet major challenges: sustainable and better governance RI, increasing of European and national funding, improved link with industry, facilitating HR mobility.'
Partnerships in Horizon 2020: a powerful tool to deliver on innovation and growth in Europe	Joint Technology Initiatives 'The Commission proposals represent significantly more ambitious partnerships than the current generation of JTIs. - JTIs will have clearer and more ambitious objectives, contributing directly to competitiveness and EU policy goals.

[20] Strategy Report on Research Infrastructures, roadmap 2010, ESFRI

	- JTIs will have improved governance to ensure openness to new participants, the allocation of funding on the basis of excellence, and better links with national activities. - Major simplification will be achieved, both in terms of the implementation structures and simpler rules for participants. - JTIs incorporate stronger commitments from industry, including substantial financial commitments at least commensurate with the EU budget contribution.' <u>Contractual public-private Partnerships</u> Contractual public-private partnerships are being considered in the following areas: – Factories of the Future; – Energy-efficient Buildings; – Green Vehicles; – Future Internet; – Sustainable Process Industry; – Robotics; – Photonics; – High Performance Computing.' <u>Public-public and other partnerships</u> 'The Commission is presenting four legislative proposals to establish public-public partnerships with member states under Article 185 TFEU for the joint implementation of national research programmes: – The second European and Developing Countries Clinical Trials Partnership – The European Metrology Programme for Research and Innovation – Eurostars 2 – The Active and Assisted Living Research and Development Programme' 'The two forthcoming FET (Future and Emerging Technologies) Flagships, Graphene and Human Brain Project, aim to create large-scale long-term European partnerships.' 'The Commission is proposing to extend the SESAR JU (Single European Sky ATM Research Joint Undertaking) under Horizon 2020.'
European Commission (2011e), Partnering in Research and Innovation, COM (2011) 572 final.	'In key areas where major societal challenges must be addressed and where European competitiveness is at stake, relevant joint programmes should be implemented on the basis of common strategic R&D agendas. These should align and pool public (European and national) and private resources through a partnering approach, involving organisations at each stage of the R&D cycle. To this end, the Commission envisages making greater use of partnering concepts and instruments developed and implemented at European level, recognising the need at the same time to avoid adverse effects on competition. A number of steps have been identified to address the challenges in relation to: - governance - implementation/funding - framework conditions'
Strategy for European Technology Platforms: ETP 2020 - SWD(2013) 272 final	'European Technology Platforms will be a key element in the European innovation ecosystem and will help turn Europe into an Innovation Union. To do this, ETPs will have to take a holistic view, identifying the pathway to commercial deployment of research, provide strategic insights into market opportunities and needs, and mobilise and network innovation actors across the EU in order to enable European companies gain a competitive advantage in global markets.'

5.3 Priority 3: An Open labour market for researchers

5.3.1 Pr.3-What it is about

Both the EC 2012 Communication and the 2007 Green Paper give high relevance to the role of researchers' labour market. The ERA Green Paper (EC 2007a) stated that researchers should be stimulated by a single labour market with attractive working conditions for both, men and women, involving, notably, the absence of financial or administrative obstacles to trans-national mobility. The EC 2012 Communication reinforces this message in priority 3 which focusses on an open labour market for researchers.

Ensuring openness, transparency and merit in the research career across the ERA is critical to make the profession attractive and thus sustain, in the long run, the right flow of human resources. The *Charter for Researchers* and the *Code of Conduct for Recruitment* (referred to as the Charter & Code) identify the principles that would characterise an open labour market for researchers. These include: research freedom, professional attitude, public engagement and professional responsibility and accountability (from the researchers); professional recognition, non-discrimination, attractive working conditions, in terms both of flexibility and salary/benefits, recognition of the experience including international and intersectoral mobility (from the employers). As for recruitment, this should be (among other things) open, efficient, transparent, supportive and internationally comparable. Candidates should be made aware of the selection criteria and the committees judging them should be gender-balanced and bring together different expertise. The Charter & Code, however, are only voluntary instruments, which institutions can endorse and ultimately apply, following the Human Resources Strategy for Research (HRS4R).

Transnational and intersectoral mobility is an important element of this priority. On the one hand, mobility is a valuable mechanism to share knowledge and thus expand its impact at the social level. On the other, it is an important part of the individual researcher's career. An open, transparent and merit based labour market would, as well as ensuring a sustainable and qualified labour force, also facilitate short and long-term mobility across borders, within and from outside the EU.

Ultimately, this priority refers to the need of selecting, attracting and nourishing talent in the research profession, providing adequate types of career support and rewards such as, attractive economic conditions, flexibility to move between research and industry, freedom to address challenging and risky projects, access to work-class facilities and so on.

According to the EC (2012a) Communication, the three different stakeholders (EC Member States and Research Organisations) are invited to act (according to each one's specific roles) on improving the recruitment and employment conditions of researcher, making sure the market is open, transparent and merit based, as well supporting/implementing the conditions highlighted in the Charter & Code in line with the HR Strategy for Researchers. Furthermore, they are also invited to help the smooth functioning of the research labour market through the enhancement, use and coordination of the EURAXESS pan-European network. Finally, they are invited to remove obstacles to cross-border access and portability of grants, to support Innovative Doctoral Training and recognise and facilitate the role of mobility between industry and academia.

5.3.2 Pr.3-Where we are now

The ERA Green Paper identified, in 2007, several barriers to the European single market for researchers. These include the limited extent and lack of harmonised rules and conditions for open recruitment in public research institutions, the lack of recognition in the labour market law of the research profession and its specificities, its poor working conditions and the existence of barriers to easily transferable pension funds. Some positive developments have, since then, occurred yet much more needs to be achieved.

In terms of conditions of recruitment and employment, the situation varies remarkably across countries. Some MS have strongly centralised university systems and in such cases, it is national laws that need to accommodate such principles. In other countries, the system is highly de-centralised, thus it is universities that ultimately establish their employment practices. Finally, other MS (from the EU-12) are experiencing a strong transition from a centralised vs a decentralised system, with all the frictions that this implies.

In the absence of adequate evaluation-studies, it is not possible to assess to what extent the principles of transparent, open and merit based recruitment are in place. However, it is possible to say that such principles have been, with few exceptions (see Doussineau et al., 2013), at least formally acknowledged. At the same time, even in countries where formally laws are inspired to openness, transparency and meritocracy, certain established institutions effectively hamper the smooth functioning of the researchers' labour market. In some MS, for instance, access to certain positions is subject to a formal, national-level evaluation process. Whilst this may be open to citizens of all MSs, non-nationals who do not possess the relevant institutional knowledge may be discouraged, preferring countries with a streamlined recruiting process (such as the Accreditation in Spain or Italy, or the Habilitation in Germany and many other Eastern European countries) . Furthermore, in certain countries, permanent appointments are only foreseen at relatively advanced stages of career (i.e. associate professor), making the profession overall less attractive. Finally, in countries severely hit by the financial crisis, a dual labour market is emerging: on the one hand researchers with a civil servant status enjoy a high degree of job stability; on the other an increasingly large segment of the labour market cannot have access to secure jobs. All in all, the different institutional arrangements and historical practices make it hard to assess the degree to which open, transparent and merit-based recruitment is practiced, thus evaluations should be conducted to shed light on how different countries are tackling this issue.

Another important aspect to be discussed is that of mobility. Research mobility has increased remarkably in the past few years (OECD, 2003; Moguerou & Di Pietrogiacomo, 2008; BIS, 2011), supported also by EC policies. Relevant initiatives, in this respect, are the Scientific Visa Package (which facilitates the procedure of admitting researchers coming from non-European countries), the Euraxess Portal[21], which offers both information and support to mobile researchers and, more in general, other mobility schemes (such as the People Programme in the FP7). The latter are "a very common and omnipresent instrument used for many different motives, such as mutual learning, capacity building and for attracting, retaining or developing human resources

[21] The use of EURAXESS as a job-portal is also remarkably different across countries. All members states have a website in place, however, in some MSs the use of the portal is encouraged by national measures (laws or strategies), whereas in others national-level websites are preferred (Doussineau et al, 2013).

for S&T." (EC 2013a). An obstacle to international mobility is, however, the limited international access and portability of national grants:, the ERA Synthesis Report (Doussineau et al., 2013), indeed, highlighted that whilst the majority of countries allow for some degree of open access, much more needs to be done for grant portability.
Whilst the positive impact of mobility on knowledge production and sharing has been fully acknowledged, a more complex picture is now emerging. The increase of mobility could also reflect the lack of job opportunities for researchers in some countries (Ehrengerg 2003; Gaughan and Robin 2004) and the increase of employment insecurity in the academic working life (Bryson 2004; Cruz-Castro and Sanz-Menendez 2005; Smith-Doerr 2006; Marinelli et al 2013). The complexity of the phenomenon should be taken into account at the policy level. Both the Green Paper 2007 and the ERA Communication 2012 highlighted that doctoral education in EU is fragmented and lacks critical size at the expense of excellence and attractiveness, some progress has been made in this respect. The principles of Innovative Doctoral Training have been identified and published in 2001 by the EC (EC 2011e). These include Research Excellence, providing an Attractive Institutional Environment, Interdisciplinary Research Options, Exposure to industry & employment sectors, International networking, Transferable skills training, Quality Assurance. The Term has been introduced recently and thus does not appear often in official governments, nevertheless research conducted at IPTS under the ERAWATCH project highlights that some elements of IDT are present in the majority of countries. Finally a cross-cutting issue, highlighted already in the Green Paper in 2007 and still valid today is that the research profession suffers from a lack of a common understanding of researchers' competences, which hinders the match of demand and supply and thus the effective allocation of resources.

5.3.3 Pr 3- Where we are going

Table 3 – Priority 3 – Where we are going

EC Policy	How it relates to the priority
Europe 2020 Strategy	Within the Europe 2020 strategy, the innovation Union Flagship initiative is the most relevant to this ERA priority, as it focusses on enhancing R&D and innovation and putting them at the service of society. A single labour market for researchers is an essential condition for this to happen and indeed, one of the key aims of the initiative is to contribute to the completion of the ERA. The Flagship initiative Youth on the Move is also –albeit less directly- relevant to this ERA priority. Indeed, it aims to enhance the performance and international attractiveness of Europe's higher education, raising the quality of all levels of education and training and enhancing mobility.
Common and general Provision for EC Funds (ERDF, ES, CF, EAFRD, EMFF)	Although the critical importance of research and innovation (and thus that of researchers' labour market) is acknowledged in the EU funds, they have limited direct impact on this priority as they are not designed to develop a unique labour market for researchers.
European Regional	Whilst formally, the ERDF is not directly linked or associated

Development Fund	to the creation of the ERA (nor of this ERA priority in particular), there are several ways in which it can, indirectly, enhance it. The ERDF can support investment in education, skills and lifelong learning by developing education and training infrastructure; Furthermore, it can be used to enhance the competitiveness of SMEs, facilitating the exploitation of new ideas. Potentially such investment can positively affect training and career development for researchers, as well as provide opportunities for mobility between academia and the private sector.
Horizon 2020	One of the priorities of Horizon 2020 is "Excellent Science", which is directly relevant to the creation of an open labour market for researchers. Under "Excellent Science", Horizon2020 will –among other things- support the most talented and creative, provide researchers with excellent training and career development opportunities and promote world-class research infrastructures. Furthermore, to contribute to the attractiveness of the research career, Horizon2020 will pay attention to the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers, together with other relevant reference frameworks.

5.4 Priority 4: Gender equality and gender mainstreaming in research

5.4.1 Pr. 4- What it is about:

Priority 4 covers the issue of gendered science[22]. In the ERA Green Paper (EC 2007a), the issue of gender was given less prominence as it was covered, together with other aspects, under the old priority 1 (Realising a single labour market for researchers).

To discuss this priority it is useful to recall the definition of gender accepted and applied in EU documents: gender is "a concept that refers to the social differences between women and men, that have been learned, are changeable over time, and have wide variations both within and between cultures".[23] As such, gender should not be understood exclusively as an attribute of women and men, rather it also refers to the socially constructed relationship between the two.

Drawing on Bíziková et al (2007), science, as a social institution as well as an activity and a set of theories, can be viewed as gendered in two main ways:

- **In relation to content**: science (or at least some parts of it) reflects in its contents and norms of behaviour, its historical roots. As an activity dominated by men, scientific enterprise itself became interconnected with the character traits

[22] This section draws heavily from Bíziková, et al. (2007).

[23] EC (1998).

traditionally seen as male. Furthermore research has often been gender-blind. In other words, scientific conclusions drawn from studies based on one sex, have been automatically extended to the other. These issues are, inevitably, reflected in scientific theories, paradigms and methodologies.

- **In relation to research performers**: in the research profession women are under-represented, especially in the top-positions. This is despite they constitute about the half of first degree holders.

Achieving equal treatment between women and men, requires going beyond simple equality of opportunities. The concept of gender mainstreaming has been developed for this very purpose. The latter complements the former, and can be defined as a long term strategy aimed at "*the systematic integration of equal opportunities for women and men into the organization and its culture and into all programmes, policies and practices; into ways of seeing and doing*" (EC 2000b, page 2).
Gender mainstreaming, thus involves, as well as promoting and monitoring female participation in research activities, taking into account the gender dimension of research. The latter implies avoiding gender-blindness when setting up a research agenda, taking into account both male and female preferences and exploring scientifically the gender dimension of any topic.
To conclude one needs to point out that the importance of this priority lies not only on the moral need to achieve equality of citizen across genders, but also on the strategic role of scientific activities. The low female participation on this crucial sector is effectively a waste of talent that the EU cannot afford; furthermore, the negligence in tackling the gender dimension of given topics, results in poorer scientific and technological outcomes which have both social and economic implications.
Against this background the EU has thus invited Member States to remove legal and other barriers to full gender equality and mainstreaming, to engage in partnerships with other institutions to foster cultural change, as well as to take adequate steps to ensure that at least 40% of the under-represented sex participate in decision making committees. Research organisations are invited to align their research strategies along similar priorities, developing and implementing appropriate Gender Equality Plans. The commission, along the same lines, is committed to fostering gender equality and the integration of a gender dimension in Horizon 2020 programmes and projects. Furthermore, it proposed in 2013 a *Recommendation to Member States* with common guidelines on institutional change to promote gender equality in universities and research institutions.

5.4.2 Pr.4-Where are we now:

Despite national and EU-level strategies on gender equality, women are still underrepresented in the research profession.[24] The report She Figures 2012 (EC 2013b) shows that, in 2009, women accounted for only 33% of the EU-27 researchers. Furthermore, whilst the female proportion reaches 40% in the public and higher education sectors, it goes down to 19% in the private sector.

Nevertheless some positive features are emerging for new generations. In the EU-27, the proportion of female researchers has grown annually by 5.1% over the period 2002-2009, whereas that of men has grown by 3.3%. Similarly, the proportion of women

[24] This section builds heavily on the EC (2013b) report She Figures -2012.

among scientists and engineers has been going up annually by 5.4% in the period 2002-2010, compared to 3.1% for men.

Despite that, strong vertical segregation still characterises women's academic career (, the so called glass-ceiling), with female presence declining as the career progresses. In 2010, whilst the proportion of female students (55%) and graduates (59%) exceeded that of male students, the proportion of female PhD graduates was 46 %, that of female grade C academic staff was 44%, down to 37% for grade B and 20% for grade A.

Thematically, women are still relatively less involved scientific and engineering careers. In 2010, female PhD graduates were as many or more than men in all broad fields of study, with the two exceptions: science, mathematics and computing (40%) and engineering, manufacturing and construction (26%). As the career progresses, the number of female academics in these fields also decrease. In scientific and engineering fields the proportion of women PhD graduates is 35%, that of grade C is 32%, going down to 23% and 11% for grade B and A respectively.

In term of decision making, female researchers also lie behind men. In the EU-27, in 2010, 15.5% of institutions in the Higher Education sector were headed by women, and just 10% of universities had a female rector. Whilst the female presence of board members was 36% in 2010, it was only 22% in 2007, indicating a relevant improvement which, however, is partly influenced by changes in the computing methods for the EU average.

Whilst in the majority of the countries, gender equality laws are in place, legislative measures addressing specifically the population of female researchers are not common. However, other types of measures may be in place. For instance, in some countries funding agencies may have criteria that take gender into account, in other cases there may be specific advisory bodies. Furthermore, several initiatives to foster cultural change promoting female scientists and their image, are in place across MSs. These include targeted campaigns, gender/focussed events or special grants/scholarships.

Despite an overall favourable legislative environment and cultural changes, the increasing number of temporary contracts in Academia, may have generated some perverse trends in terms of gender equality: in Doussineau et al. (2013) it is highlighted that in some countries, contracts' extensions for maternity/paternity leave is not guaranteed. The same report highlights that there is a poor understanding of the concept of gender mainstreaming in research activities.

As for female representation across decision making committees, the situation varies remarkably across MSs. In some countries this topic is addressed at the legislative or governmental level, with previsions imposing a certain level of participation. In some others, there is no legislation but research funding bodies embrace this principle in their practices. In other countries, finally, the decisions is left exclusively to universities, thus it is harder to assess the situation.

Overall whilst an improvement in gender balance has been recorded, much needs to be done. In particular, the evidence suggests that the gap is not likely to close automatically, as the younger generation of students/researchers progress in their

career. Adequate active policies are required. Furthermore, the aggregate figures mask important differences across member states and need to be addressed appropriately.

5.4.3 Pr.4- Where we are going

Table 4 – Priority 3 – Where we are going

EC Policy	How it relates to the priority
Europe 2020 Strategy	Inclusive growth, which refers to need for Europe to foster high-employment and benefit from all its potential, is one of the priorities of the Europe2020 strategy . Gender equality and gender mainstreaming are important aspects of inclusive growth. The Flagship initiative "An agenda for new skills and new jobs ", for instance, aims –among other things- to identify new work-life balance models.
Common and general Provision for EC Funds (ERDF, ES, CF, EAFRD, EMFF)	Although the EC Funds do not directly tackle the development of the ERA, according to the common and general provisions, gender equality and gender mainstreaming shall be promoted in the preparation and implementation of programmes.
European Social Fund	The European Social fund, although not directly linked to the ERA, is indirectly related to this priority as one of its aims is to improve social inclusion targeting also female presence in the labour market and gender equality in a broader sense.
Horizon 2020	The importance of gender equality in research is fully acknowledge in Horizon2020. Horizon 2020 will promote equality between men and women as a crosscutting issue, by addressing the underlying causes of gender imbalance, exploiting the full potential of both female and male researchers, and integrating the gender dimension into the content of projects. Changes in the organisation of research institutions and in the content and design of research activities will also be supported.

5.5 Priority 5 Optimal circulation, access to and transfer of scientific knowledge

5.5.1 Pr.5-What it is about

The ERA Green Paper 2007 states that generation, diffusion and exploitation of knowledge are at the core of any research system. In particular it stresses that access to knowledge generated by the public research base and its use by business and policymakers lie at the heart of the European Research Area, where knowledge must circulate without barriers. This issue is taken into account in the ERA Communication 2012, under priority 5. Broadly speaking, this priority covers three aspects: open access, knowledge transfer and digital research.

Open access refers to the practice of granting free Internet access to research articles. As all research and innovation builds on earlier achievements, an efficient system for broad dissemination of and access to research data and publications can accelerate scientific progress. The Commission objective is to optimise the impact of publicly-funded scientific research, both at European level (FP7, Horizon 2020) and at Member State level. This is essential for Europe's ability to enhance its economic performance and improve the capacity to compete through knowledge. Open access is seen as one way to achieve this goal. Results of publicly-funded research can therefore be disseminated more broadly and faster, to the benefit of researchers, innovative industry and citizens. Open access can also boost the visibility of European research, and in particular offer small and medium-sized enterprises (SMEs) access to the latest research for utilisation.

Knowledge transfer, in particular between public research institutions and the private sector, is critical to ensure that scientific results be translated in innovation that can be exploited in the market. Indeed, in 2007, the same year as the ERA Green Paper, the EC also issued a Communication on improving knowledge transfer between research institutions and industry (EC 2007b) accompanied by voluntary guidelines for universities and other research institutions to ensure that their policies relating to IPR, incentives and conflict of interest optimize knowledge-transfer activities and to present good practices specifically relating to contractual arrangements. The highlight initially made by the Green Paper on the need to "overcome the deadlock on the Community patent" is no longer taken into account in the 2012 Communication, probably because significant progress has been made to the implementation of a unitary patent in the European Union.[25]
The IPR-related aspects became specifically addressed by Innovation Union[26] commitments 21 (Facilitating knowledge transfer in the FP) and 22 (Develop a European Knowledge Market for Patents and Licensing).

Digital Research refers to the strategic role of ICT infrastructures as a crucial asset underpinning European research. The Communication "ICT infrastructures for e-Science" (EC 2009) highlights such aspect and calls on Member States and the scientific communities, in cooperation with the European Commission, for a reinforced and coordinated effort to foster world-class ICT infrastructures, also known as e-Infrastructures, to pave the way for the scientific discoveries of the 21st century. To facilitate a rapid transition to distributed forms of research activities (namely e-Science), the European Commission and Member States have made significant investments in e-Infrastructures, including the pan-European research network GÉANT, e-Science grids, data infrastructures and supercomputing. The ERA Communication complemented this list of objectives with the implementation of national strategies for electronic identity for researchers giving them transnational access to digital research services. “The development of e-Infrastructures has an inherent international collaboration dimension. It supports European research by

[25]The Commission issued important documents related to the creation of unitary patent protection (European Commission, 2011f,g). Furthermore, the Council adopted in 2011 an agreement to establish a Unified Patent Court in MS.
[26] One of the seven flagship initiatives of the Europe 2020 Strategy which was agreed by Member States in June 2010

providing the facilities needed to carry out world-class science through the collaboration of research teams, regardless of their country and geographic location." […] These global e-Infrastructures constitute a key element of a seamless digital European Research Area open to the rest of the world and provide a decisive contribution to tackle global research challenges." (EC 2012b)

Accordingly, the EC (2012a) Communication invited the three different stakeholders (EC, Member States and Research Organisations) to act (according to each one's specific roles) and create synergies on:

(i) Implementing policies and specific measures on access to and preservation of scientific information.

ii) Ensuring that public research contributes to Open Innovation and foster knowledge transfer between public and private sectors through national knowledge transfer strategies

(iii) Harmonising access and usage policies for research and education-related public e-infrastructures and for associated digital research services enabling consortia of different types of public and private partners

(iv) Adopting and implement national strategies for electronic identity for researchers giving them transnational access to digital research services

These four axes are summarized along the document under the three headings described above: ***Open Access***, ***knowledge transfer*** and ***digital research***.

5.5.2 Pr.5-Where we are

Overall, Member States are very active in both open access and knowledge transfer, although, for Open Access, it is not always easy to distinguish between national policies and measures -even at ministry level- trying to rationalize what are in essence stakeholders initiatives. As for digital ERA, and in particular regarding electronic identity for researchers, EU-wide platforms initiatives (for instance eduROAM) consitute a strong catalyst for Member States' involvement. Below, we discuss the progress along the three dimensions in more detail.

Open Access:

Although Member States are not equally advanced in how they support and address the issue of open access (OA), there is a general trend for improvement, confirmed by a report on open access and preservation policies (European Commission,2011h) that shows that compared to 2009, the situation has improved in many countries.

According to the Science-Metrix (2013) study, most governments have not proposed or implemented direct national legislation on OA. Instead, OA is often addressed through less formal means, such as the production of guidelines for research funding agencies.

Funding and soft measures have been adopted at EU level to support the development of open access. As a result of FP7, scientific publications resulting from a set of EU-funded projects are now increasingly available in open access. For

instance, out of the 42.100 publications published in FP7, 16.697 were in Open Access and 25.299 were in embargo period[27]. However, despite their relevance, FP-funded measures concern only a very limited share of EU's overall R&D expenditure and their impact remains thus limited.

National declarations of support to Open Access (such as the Berlin Declaration[28] signed by 444 organizations worldwide by August 2013) have been made in several countries but they are not automatically reflected in the deployment of binding national Open Access policies.

In spite of the variability in national policy-making on Open Access (OA), the wide participation to the EU OpenAIRE[29] OA platform indicates the relevance of initiating EU-wide platforms as a catalyst for Member States' involvement. The Digital Repository Infrastructure Vision for European Research (DRIVER[30]), is another Europe-wide initiative (upon which Open AIRE is built) established to build a cohesive network of repositories for research and education, including over 3,500,000 scientific publications harvested regularly from more than 295 repositories, from 38 countries.

The EU is also active in global discussions on Open Access, e.g. via Science Europe's representation in the Global Research Council.

Regional and/or linguistic initiatives on Open Access are emerging. For instance research and funding institutions from Austria, Switzerland and Germany co-operate in the http://open-access.net/de_en/homepage/ online platform; or the Alhambra Declaration signed by open access stakeholders from South European countries (Spain, Portugal, France, Italy, Greece and Turkey); or COBISS.Net which enables free flow of bibliographic material among Bosnia and Herzegovina, Bulgaria, Montenegro, Macedonia, Slovenia, Serbia and Albania; or Latindex and Dialnet which aim at collecting and facilitating access to research publications produced in Spanish and Portuguese speaking countries.

There are currently still fewer policies in place for open access to scientific data than for open access to publications (Science metrix, 2013b).

Knowledge Transfer:

Although knowledge transfer between public research institutions and the private sector to foster innovation was considered as insufficient in the Impact Assessment accompanying the 2012 ERA Communication EC (2012c), it is currently among the actions most actively addressed within priority 5 in Member States (even if only partially addressed) by some governments and stakeholders.

In 2011, in line with the Innovation Union flagship initiative, the Commission launched the "TTO Circle[31]", an initiative that aims at enhancing collaboration among the TTOs (Technology Transfer Offices) of large European public research

[27] Source: http://www.openaire.eu/en/component/openaire/stats/default/393
[28] http://oa.mpg.de/lang/en-uk/berlin-prozess/berliner-erklarung/
[29] http://www.openaire.eu . Stakeholder organisations from 23 Member States + 4 associated countries are signatories to OpenAire (http://www.openaire.eu/en/about-openaire/partner-info)
30 http://www.driver-repository.eu/
[31] http://ec.europa.eu/dgs/jrc/index.cfm?id=6480

organisations, and gathers 25 stakeholders from 11 Members States (IT, FR, DE, BE, UK, SE, ES, NL, FI, EI, DK) and from associated countries (NO, CH, TR, IL). One of the task of the TTO Circle is to foster the sharing of expertise, the exchange of best practices and the development of synergies at the European level in the field of IP and knowledge transfer.

Regarding the management of intellectual property in knowledge transfer activities, the Commission issued a Recommendation EC(2008) 1329) together with a Code of Practice for universities and other public research organisations. This Recommendation provides Member States and stakeholders with a set of best practices and policies to stimulate knowledge transfer. According to the survey of Knowledge Transfer Offices (KTOs) (Empirica GmbH, Fachhochschule Nordwestschweiz and UNU-MERIT, 2013) aiming at assessing the uptake by KTOs of the EC Recommendation's Code of Practice, universities obtain more invention disclosures, start-ups, license agreements and research agreement per 1,000 staff than research institutes, but the latter outperform universities for patent applications, patent grants, and license income. The 2013 survey also shows that:

- Three of the principles are seemingly not widespread let alone generally accepted among PROs: the creation of coherent IP portfolios and patent/IP pools (CoP 5), the existence and publication of a licensing policy (CoP 11), and the publication of start-up policies (CoP 12) are all realised by only few responding institutions. The other 15 principles are at least partially accepted and in the majority of surveyed institutions implemented.
- Publishing policy documents (on IP, publication/dissemination, licensing, and start-up policies) is not common practice at the surveyed PROs. Along the same lines, while PROs monitor internally their IP protection and knowledge transfer activities and achievements (CoP 14), they neglect, to some extent, the publication and dissemination side and consequently might fail to raise their visibility to the private sector.
- PROs provide incentives to mobilise their employees for IP issues and KTT and they let them participate in the resulting revenues in one way or the other (CoP 4, 13). Monetary incentives are a lot more frequent than other incentives, even if the CoP stipulates that monetary incentives should not be the only ones.

Digital ERA

A broad picture, regarding the current level of implementation of the Digital ERA, can be derived from the eResearch 2020 study (Empirica Gesellschaft für Kommunikations et al. 2010). A large majority of the survey respondents(80%) finds it likely or very likely that new resource delivery models such as Software as a Service, Cloud Computing or Utility Computing will spread and have a significant impact in science in the next five years. There is also wide agreement on the necessity and benefits of National and international Grid Initiatives. In particular, statements on the necessity for coordination bodies and for optimising operation and support of distributed computing services are acknowledged by at least four out of five respondents.

Regarding the electronic identity for researchers, the success of eduROAM[32] illustrates the relevance of initiating EU-wide platforms as a catalyst for Member States' involvement. Having started in Europe, eduROAM has gained momentum throughout the research and education community worldwide and is now available in 60 territories worldwide including all the EU Member States. In November 2010, all of the 37 GEANT[33] project partner countries were covered by EduROAM. Complementary to EduROAM, the EduGAIN service is intended to enable the trustworthy exchange of information related to identity, authentication and authorisation between the GÉANT (GN3plus) Partners' federations. Currently 15 Member States (BE, CZ, DE, DK, EL, ES, FI, FR, HR, HU, IT, LV, NL, SE)[34] are members of EduGAIN. Another international initiative is the Research and education networking (REN) which is the provision of computer networks for interconnecting research and educational institutes in order to facilitate exchange of information for research and teaching purposes. Research and education networks can exist at local and regional levels, although in most countries they are formally organised as National Research and Education Networks (NRENs)[35]. As well as physical connectivity, research and education networks often provide other services such as access federations, specifically NREN Identity Federation to which national universities are (partially) connected. EU NREN Members include 24 Member States. Also, REFEDS (Research and Education Federations), a collaborative body of research and education identity federations worldwide has, among its members, federations from 16 EU Member States[36].

5.5.3 Pr.5-Where we are going

Table 5 – Priority 4 – Where we are going

EC Policy	How it relates to the priority
Europe 2020 strategy	Knowledge and innovation are at the core of the growth strategy of Europe2020, with two flagship initiatives playing the most relevant part for priority 5: (i) "A Digital Agenda for Europe", where the aim is to deliver sustainable economic and social benefits from a Digital Single Market based on fast and ultra fast internet and interoperable applications, with broadband access for all by 2013, reaching higher internet speeds (30 Mbps or above) by 2020

[32] eduROAM (education roaming) is world-wide access service that enables students, researchers and staff from participating institutions to obtain Internet connectivity across campus.
[33] The GÉANT network is the pan-European communications infrastructure serving Europe's research and education community, co-funded by European National Research & Education Networks (NRENs) and the EC
[34] Source: http://edugain.org/technical/status.php
[35] These networks are usually interconnected with other research and education networks, as well as to the wider Internet.
[36] Source: https://refeds.org/resources_list.html

	(ii) "The Innovation Union" flagship initiative stresses the importance of Business-academia collaboration through "knowledge alliances" (Commitment 2); open access to the results of publicly funded Research and the development of smart research information services (commitment 20); developing mechanisms to strengthen knowledge transfer offices in public research organisations, in particular through trans-national collaboration (Commitment 21); a European knowledge market for patents and licensing (Commitment 22). At EU level, the Commission will work to improve framework conditions for business to innovate (eg. modernise the framework of copyright and trademarks, improve access of SMEs to Intellectual Property Protection, speed up setting of interoperable standards; promote knowledge partnerships and strengthen links between education, business, research and Innovation. At national level, Member States will need to reform national (and regional) R&D and innovation systems to foster excellence and smart specialisation, reinforce cooperation between universities, research and business
European Regional Development Fund	*One of the aims of the ERDF is* technology transfer, and open innovation through smart specialisation, as such, it is critical for the 5th ERA priority.

Horizon 2020	The Commission will make compulsory open access to scientific publications a general principle of Horizon 2020. Horizon 2020 addresses various aspects directly covered by priority 5: (i) The general support to research infrastructure, is also critical for knowledge sharing, open access and the digitalisation of the ERA. Indeed Horizon 2020 will support ICT-based e-infrastructures as a vehicle to achieve by 2020 a single and open European space for online research where researchers enjoy leading-edge, ubiquitous and reliable services for networking and computing, and seamless and open access to e-Science environments and global data resources. (ii) Horizon 2020 reminds that Europe can achieve critical mass through partnering, clusters and networks, standardisation, promoting cooperation between different scientific and technological disciplines and sectors, in particular the implementation of research and innovation agendas through public–private partnerships, the building of effective industry-academia links, the leveraging of additional investments, the access to risk finance, standardisation. (iii) The EIT's specific objective is to integrate the knowledge triangle of research, innovation and education and thus to reinforce the Union's innovation capacity and address societal challenges. (iv) The aspect of e-identity is also touched upon, where "the aim is to support Union policies for internal and external security and to ensure cyber security (…/…) in order to take into account the evolution of security threats and privacy protection".

6. Summary and conclusions

This second edition of the ERA fabric map provides a snapshot of the ERA today (November 2013), framing it against the transition from the six dimensions of the 2007 Green Paper, to the five priorities of the 2012 Communication. The report is built to support the development of alternative future scenarios for the ERA under the VERA project.

It shows that responsibilities for research and innovation and related policy domains are shared between the EU and its member states, and that the landscape of European institutions, bodies and discussion fora involved in research policy in Europe is quite complex.

Whilst progress has been made with regard to the five ERA priorities described in the ERA Communication 2012, completion by 2014 seems unlikely. Indeed, the multi-level governance of the ERA, which requires cooperation and engagement at the level of MS, regions and EU institutions, makes the task extremely challenging, raising the importance, on the one hand, of policy instruments geared towards, mutual learning and negotiation and, on the other, of sophisticated monitoring and evaluation mechanisms. This is all the more important when considering that the ERA priorities themselves strongly overlap between each other (Haegeman et al, 2013). For instance, transnational research-programme cooperation networks (considered in priority 2) also develop activities which relate to mobility and knowledge circulation and transfer such as summer schools, exchange programmes for young researchers (typically falling under priority 3). Similarly, transnational cooperation networks contribute to non-research related policy areas relevant to ERA through activities related to the review regulatory frameworks, the formulation of standards, and support to SMEs.

At the policy level, ERA appears to be a cross-cutting objective of different type of measures, including the directly relevant research innovation policy (with the phasing out FP7 programme and the forthcoming Horizon 2020) as well as the broader regional policy (with increasing importance given to research and innovation as a tool for development).

To conclude, the ERA looks increasingly like a scientific laboratory, where adequate instruments and economic support need to sustain different actors, who must be ready to share knowledge and trust, adjust their pace to the common objective, negotiating across their different needs and traditions.

The evolution of research systems, the increased internationalisation of sciences, the convergence towards a common market for researchers, capable of benefitting from all its members thus overcoming barriers to the full participation of female scientists, as well as free circulation of knowledge are all ambitious targets that will continue to require utmost coordinated efforts and financial support.

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European Commission
EUR 26433 – Joint Research Centre – Institute for Prospective Technological Studies

Title: ERA Fabric Map – Second Edition

Authors: Elisabetta Marinelli, Alexander Degelsegger, Katharina Buesel, Mariana Chioncel, Mathieu Doussineau, Karel Haegeman, Gérard Carat, Patrice dos Santos, Stephanie Daimer

Luxembourg: Publications Office of the European Union

2014-55 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424 (online)

ISBN 978-92-79-35074-0 (pdf)

Doi:10.2791/63680

Abstract

This ERA fabric map gives a snapshot of the ERA today. It looks at the division of responsibilities between EU and Member States, and at institutions and bodies involved in the European research system. Starting from the 5 ERA priorities described in the ERA Communication 2012, the report then looks at where we are today, and which direction the future is taking, given the policy context of the Europe 2020 strategy and the incoming Multiannual Programming Framework 2014-2020. The key contribution of the report is to map the evolution of the ERA highlighting the elements of continuity and discontinuity between two key documents, the 2007 ERA-Green Paper and the 2012 ERA Communication. This second version of the ERA fabric map updates the first ERA fabric map. As with the first edition, the main objectives are to provide strategic knowledge for the governance of the research, technology, development and innovation (RTDI) system in Europe. It also provides input for the implementation of the 'Visions for the ERA' (VERA) project by giving a snapshot of the ERA today, in support of developing alternative future scenarios for its evolution.

LF-NA-26433-EN-N

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Publications Office

doi:10.2791/63680
ISBN 978-92-79-35074-0 (pdf)